THE SPIRITUAL INTERPRETATION OF NATURE

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TO

MY FATHER

"He is in the world, and the world is being made by Him, and the world knows Him not."—JOHN i. 10 (from my father's Bible).

PREFACE

THESE chapters, which have grown out of courses of lectures delivered both in this country and in America, are addressed to those who in their earlier outlook upon Nature felt sure of her inherent spirituality, but latterly have found difficulty in bringing this conception into line with some of the results of modern scientific thought. They contain, therefore, little for the specialist in science and philosophy, except perhaps in Chapters III. and IV., whose conclusions may suffice for the general reader. For some schools of theology, they possibly contain nothing at all.

Where a writer's range of indebtedness is great, it is hardly possible to indicate it even by continuous footnotes, although that has been attempted here in some degree. In addition to the stimuli of many writings—in particular the volume of *Papers read before the Synthetic Society*, kindly given to me by Mr. Wilfrid Ward—I would acknowledge my gratitude to him from whose New Testament I have taken his reading of a familiar verse, while to Dr. Sutherland Black I have owed much through many years. Nor can I refrain from stating what I have learned in conversation from my friend Professor John Clark of Boston University. Certain chapters and pages on topics relevant to their

lines of special study have been read by my friends Dr. Cargill Knott and Dr. J. H. Ashworth, while Dr. John Kelman has added to a long list of kindnesses by reading the book in proof. Finally, I would express my indebtedness to Messrs. T. & T. Clark for their courtesy in permitting my use of the article "Biology," contributed by me to their *Dictionary of Ethics and Religion* as a basis for Chapters III. and IV., as also to Mrs. H. M. Bernard for permission to use the illustration on p. 74 from her husband's book, *Some Neglected Factors in Evolution.*

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INTRODUCTION

In that intellectual conquest of the world which is the aim of every thinking man, no moment is more decisive than that in which he resolves with Matthew Arnold to see things steadily and see them whole. Like every human quest of the ideal it is unrealisable on this plane of existence, being an attribute of the Divine. But the aspiration itself is significant and bears witness to that in man which is more than merely human.

The moment is fateful in many ways. In it is begotten a discontent that no closed system of science or philosophy or theology will ever satisfy. The more complete the system, the more acute the irritation. Particularly in the comparative study of the reciprocal influence of the two great viewpoints of truth that are roughly characterised as religious and scientific is this unrest felt. The average man is educated in secondary schools where nature study is increasingly demanded. He passes through courses of scientific instruction, and sooner or later—if he thinks at all—he is compelled to contrast the fundamentals of this discipline with the fundamentals of a theology which is still largely mediæval. His endeavour is to reach an interpretation of Nature, to attain an account of things that will be consistent, not merely with itself but with this other record; but he soon realises that there is much that is disparate in the two points of view, many things that are

mutually destructive, and particularly in the regions where science and theology directly impinge is the incompatibility felt to be greatest.

It is open to remark that such an intellectual restlessness is quite gratuitous,—how can there be relationship in any sense between the conceptions of science and theology? Thus from the side of science it is said: "So far as I have been able to ascertain, after many years in which these matters have engaged my attention, there is no relation, in the sense of a connection or influence, between Science and Religion. There is, it is true, often an antagonistic relation between exponents of science and exponents of religion when the latter illegitimately misrepresent or deny the conclusions of scientific research or try to prevent its being carried on, or, again, when the former presume, by magnifying the extremely limited conclusions of science, to deal in a destructive spirit with the very existence of those beliefs and hopes which are called 'religion.' Setting aside such excusable and purely personal collisions between rival claimants for authority and power, it appears to me that science proceeds on its path without any contact with religion, and that religion has not, in its essential qualities, anything to hope for, or to fear from, science."[1] Regarding the somewhat shallow characterisation of "those beliefs and hopes which are called 'religion,'" we only remark that many of them are held by men of strong and sound mind, who simply would not entertain them if they lacked connection with the general, nay, with whatever special scientific, scheme of thought they have adopted. Their sense of the unity of knowledge, *i.e.* the unity of truth, compels them to consider the relations of scientific and theological thought. Know-

[1] Sir E. Ray Lankester, *The Kingdom of Man*, p. 63.

ledge or Experience is not divided into water-tight compartments where the activity in one compartment is absolutely isolated and uninfluenced by what goes on in any other. There is, to say the least, a tendency towards ultimate unity and rationality in all experience. Whether that unity is in the attaining human mind, or in some mind external to it, does not really matter at this stage. The indications of it are there, and they are only perceived by mind. These approximations towards unity suggest that there is a complete understanding, a perfect knowledge, a final statement,—in short, that knowledge (truth) is a whole, even as the universe, of which knowledge is the attempted comprehension, is a whole; and all the parts are interdependent.

On the other hand, there are those who maintain that in the scientific and philosophical contemplation of Nature there is nothing that is of assistance to theological thought. The experiences of the human soul in every age are for them the only important facts; they are the only valid witness to divinity. Here in the communion of the soul with God the religious man has that which alone is of real and lasting value, that, moreover, which science cannot take from him. The objective side of religion, so far as it is expressed in dogma, may be suffered to go its own way: it is not ultimately necessary, it is something always vulnerable by scientific criticism. The rich spiritual experiences of the soul wherein it hopes, and fears, and loves, and learns, are the only witness, clear and unequivocal, to the Source of Being. Such a mind may even think it blasphemy to attempt to find out how God may be expected to act, from a consideration of His working in the past and present: it affirms only a rich incalculable liberty of action which

the waiting soul may gladly experience, but will never even attempt to systematize. A life of faith, of rapture, of unexpected and unimaginable experiences —in these alone is found the transcendent witness to Divinity. So W. Herrmann, in Ritschlian endeavour to obtain a place for religion where she will be unassailable by the solvent touch of science, insists: "The evangelical faith, because it ought to be an independent possession of the moral personality, must remain unentangled with the present-day development of free natural science."[1] But any isolation of these soul-states is purely fanciful. They may be proffered tokens of a transcendent Presence, but they are also linked with the ordinary life of the individual who experiences them, and so with the life of the world. They may even, as being given and experienced in consciousness, become legitimate objects of scientific examination and account, incomplete and partial as that account may be. If on one side in touch with the unseen and eternal, they yet are set within the temporal and visible.

And further, this extreme position, when regarded from the standpoint not merely of the unity of human knowledge but of the unity of Nature, is seen to be little less than intellectual suicide. For if the world is God's, then must it bear witness to divine origin and control, and the one thing that can no longer be permitted is the isolation of any special object in the universe, *e.g.*, man, or any faculty of that object, and the predicating of it relations and correspondences that are construed to imply an essential incompatibility between that object and the whole of which it is a part. If God is, then that which He has made must bear witness to Him; it must be in some sort of

[1] *Die Religion*, Preface, p. iv.

intelligible relation to Him.[1] Science and Religion afford two partial accounts of that ultimate unity in which every man lives and moves and has his being. For even if it were granted that the one moved more in the realm of Intellect and the other in that of Feeling, yet it is in consciousness that man is aware of them both and exercises himself in relation to them. Through them he comes into correspondence with, and forms his idea of, the Divine Nature.

Natural Science and Theology are thus two living bodies of thought which in virtue of their very life—life that implies assimilation of all assimilable elements in its environment—grow and expand and change from age to age in outward form and inward content, and shall continue so to do until that day when their relationship as complementary expressions of fundamental truth will be universally appreciated. And while this implies that in general all features that are obviously contradictory must be excluded, there is at the same time no call to insist upon absolute correspondence of detail between all schemes of scientific and of theological construction, still less to attempt any so-called reconciliation between Science and Revelation. If, then, there is this fundamental linkage of thought, this reciprocal influence of allied studies, it is beside the mark to urge that the day in which Theology had anything to hope or fear from Science is past. In an age whose practical interest is sociology and which tends to express its religion in terms of psychology, it may be difficult to persuade men that the relations of scientific and religious thought will be an increasingly important

[1] Acts xvii. 26–28; Rom. i. 20. Paul, in the latter passage, seems to indicate his impression that primitive peoples reached their belief in God not through intuition, but through some mode of reasoning akin to the argument from design.

question. Yet the philosophy of Nature, in whatever terms expressed, cannot but touch her sublimest product; it is man's way of thinking about her, of studying his relation to her. It may be formulated in many ways, —there are many systems. We want to reach that one which shall most truly include all the facts and most worthily express man's possibilities. To-day we cannot but be aware of views specially characteristic of the age, that are moulding the minds and even the hearts of men. The workers whose dealings are with Nature feel very certain of her, and some amongst them build up their whole view of things, starting from what they believe they know, while the doctrines that have been collected under the name of theology they tend to set on one side as being largely in the clouds and apparently without any definite connection with the mass of knowledge ordinarily acquired. And so there has come about a gradual alienation of certain strong and scientific minds, who, while they maintain that there is a natural history of the spirit, tend to forget that there may also be a spiritual history of Nature. Accordingly, when it is suggested that the theologian should strive to appreciate for himself the religious implications of science, it is not because men are saved by science—though there is more than one very true sense in which one would not care to dispute the statement—but rather because of the sympathetic value to himself in putting his mind in touch with the trend of the most distinctive thought of the day, and so furnishing himself with additional means of bridging the gulf between his intellectual hemisphere and that of his usually more accurate, if more prosaic, scientific neighbour.

But those whose business is the commerce of the mind are few compared with the vast companies who buy and

sell or live by the sweat of their brow. And yet it is only a question of time till many of the deliberations of the scientific society become the debated questions of the factory yard and market-place. Hence arise the perpetual difficulties of popular thought. To bring these out, let us consider the close parallel that subsists between the advance of an army and the intellectual and spiritual progress of a Church. In front are the prospecting scouts whose duty it is to ascertain the path by which the main body may proceed with greatest safety. It is their business to be on the outlook for every indication of fresh light, to know the times and seasons, to test the value of any movement in a specific direction, to detect all sources of possible danger. To them must be given perfect liberty of investigation: they know that they carry their lives in their hands. Behind them marches the main body, at a very ordinary pace, moving along with definite halting-points; while in the rear come the laggards, those who have failed to keep up with the main body, for reasons which may be in no way discreditable to them. It would thus appear to be impossible to bring everyone forward at the same time. As a result, country that is familiar to the scouts is just looming on the horizon of the main body, while it is a *terra incognita* to the rear. Truth, which is now old to some of us, is only arriving elsewhere. This is the case not merely with the different mental groupings of our own people; it holds good of the wide world.[1] Those questions concerning the relationship of scientific and religious thought will always be with us in some form or another. At one time the clouds may be lying thick upon the army in the plain below, while the scouts are above it high up on the mountain slopes. At other times it may be

[1] Cf. P. N. Waggett, *Religion and Science*, p. 20.

those who have pressed upward and onward to look ahead who have found themselves temporarily caught in the mist, while it is clear in the valley below. Nevertheless, the mists are ever there in some degree at one point or another,—a necessary element of our earthly existence,—and shall be until that morning breaks when they roll away for ever, and "we shall know even as also we are known."

Further, men can no longer remain insensible to those great scientific truths that have a direct bearing upon conduct. The moral significance of the essential unity of life, the place and implication of life and death in Nature, and the principles of heredity, are instances from the organic realm that offer food for reflection which will assuredly be a necessary part of the fare of our successors; the inorganic realm is likewise by no means devoid of similar spiritual aliment. And it is not merely on the constructive side that this generation finds itself face to face with a new work, but there is much call for careful combat of half-truths which are often in their results more direful than a genuine misstatement. Thus it is not difficult to twist the doctrine of the survival of the fittest into confirmation of the most disastrous conclusion that whatever is, is right. This must be met by showing that the surviving fitness need not necessarily have any moral content, and is never synonymous with perfection. Again it is possible to lay such emphasis on certain aspects of scientific truth that the individual shall feel that he is of no account. This must be balanced by the more significant truth that every human being is a trustee of those hard-earned gains of the æonian generations of life that have accumulated to form the natural and spiritual estate of man, and as such has an account to render.

It is therefore positively in the interests of the soul

bent on the adventure of faith to realise the essential kinship of all knowledge, but more particularly the identity of mental attitude that is required of him who would understand the courses of the stars and the ways of God with man. It is no longer possible to maintain a radical distinction between mental or natural science and theology either in the nature of the facts with which they deal, or in the human powers that are brought to bear upon these facts, or yet in the methods of reasoning that may be applied to the facts. For theology, when she treats of the being of God, can but draw her data from the facts of the spiritual and natural worlds as they are written in the Bible, in the pages of philosophy and science, and in the experience of the individual. To some these proofs may be insufficient and unsatisfactory, but there are no others. The world as the great antecedent fact of divine creation may surely be held to contain within itself the interpretation not merely of its parts but of its relation to that which constitutes its Ground.[1] And it is the most striking fact in this connection about the teaching of Jesus that He continually saw and pointed out the reflection of His spiritual instruction in physical events. The natural and the spiritual were united in His parables as they are united in reality,—two aspects of the same thing yet hardly contemporaneous, for that which is first is natural, afterwards that which is spiritual. It is only the heart that is in total ignorance of what religion is that either in fear or scornful joy can imagine that any such inquiry can result in damage to religion. The sense of dependent relationship that is involved in religion cannot be touched by any study of the intellectual account of religious experience usually termed theology. The personal attachment to

[1] Cf. J. Bascom, *Evolution and Religion*, p. 35.

Jesus Christ that is at the heart of any genuine Christian endeavour, whether individual or social, is unaffectable by theories of His life and work. It furnishes its own justification, and by this the association of miracle or of wonder with Him is judged, not *vice versa*. To this distance the following studies do not extend. We are simply concerned with the basal elements in all experience, and the relation of the particular intellectual accounts that have been popularly labelled "religious" and "scientific." In face of the rapid formation of a definite religious public opinion outside the churches, in face of cleavages of opinion within the church, in face of the fast developing recognition of the essentially spiritual character of much of modern science, and the essentially unscientific character of much ancient theology, it is necessary that our age look at these questions afresh for itself. In the interpretation of Nature man has always felt himself close to the highest he has known. The hearts of the Nature-worshippers of long-past days responded to a real witness of divinity, and we may be very sure that a religion that resolutely refuses to regard this element will make but a limited appeal, and that the book of reconstructed Christian theology will contain chapters whose inspiration will be found in the purified and reverent contemplation of Nature.

CHAPTER I

KNOWLEDGE AND FAITH

AT the threshold of all inquiry lies necessarily the question of the nature and character of Knowledge, but particularly in estimating aright the reciprocal influence of Science and Religion, so often contrasted as Knowledge and Faith, is such initial investigation in part demanded. Now the results of experience—the ultimate unity and rationality of which we have already postulated—however they may be acquired, whether won at first hand or received upon the authority of others, are collectively regarded by the individual mind as knowledge. Yet there is knowledge and knowledge. The man in the street has knowledge of a certain kind; he knows that the sky is blue, that the grass is green, and many other facts whose practical value is probably greater to him. But pass into the laboratory, and the physicist will show us that the luminosity is due to the partial reflection of light from the upper regions of the atmosphere; because of the minuteness of the particles of air, the rays of quicker vibration are sent back in greater quantity, thus producing a general tint of blue. The botanist will likewise tell us that the verdure of the grass is accounted for by the existence of minute intracellular living units called chloroplasts containing a green substance known as chlorophyll, whose function is to catch more particu-

larly the red rays of light in order to employ their energy in the difficult chemical operation of decomposing carbon dioxide and water in connection with the process of assimilation. As a matter of habit and custom we have come to think of the latter type of knowledge as scientific, and of the former as unscientific.

Now there is no reason to doubt the facts of the street-man's knowledge; we no more question the genuineness, the reality of the odd fact that he picks up in one thoroughfare than that of the old button which he picks up in the next. And yet his knowledge differs from that of the man of science. In what respect? It is in general a knowledge of isolated unconnected facts: the knowledge of the trained scientific mind, on the other hand, is a knowledge of facts and their relationships. The two vary as the heterogeneous contents of a schoolboy's pocket differ from the ticketed objects in the glass-covered case of, say, a geological museum. The bit of string, the pocket-knife with one blade broken, the dead mouse, the half-chewed apple, the glass eye gouged out of his sister's doll,—there is no bond of connection between them. On the other hand, the ordered series of fossils in the museum, arranged to exhibit their relations and interrelations, systematically express the results of years of laborious investigation.

The foundation of all scientific knowledge is facts—facts physical or mental, facts culled by external observation or internal observation — everything, in short, that has the power of being revealed to consciousness. Facts are the premises of knowledge: according to their importance they are the bedrock upon which, or the bricks out of which, the superstructure—the Temple of Knowledge—is built. As

such, previous to their employment, they must be critically inspected, and if, as the result of this inspection, their nature and limits cannot be determined, if they cannot be separated from all other facts so as to stand out clear and defined, the man of science will refuse to use them. Further, the man of science will not make use of facts that are incapable of verification or test. A series of individual experiences that are out of all relation to anything that he or his fellows have known,—which he cannot therefore classify or collate,—will not receive a place in the construction of his science. He may, so to speak, keep such experiences and facts in storage, waiting until some others like to them are chronicled, so as to be available for comparison, but, in general, a set of experiences that are insusceptible to repetition by another would constitute no part of a science. On the other hand, such uniqueness would not necessarily in itself involve them in discredit.

Finally, these ascertained, verified, classified facts must be wrought into a system. Nothing less than this can transform unscientific knowledge into scientific knowledge. Scientific knowledge is systematized knowledge in which the personal equation has been eliminated. The slow accumulation of data, the year-long studies of the specialist, the reiterated experiments of the patient researcher are all conducted in the hope that they will eventually lead to the discovery of law. To the true man of science this ultimate ideal, this impulse towards unity, means just as much as the rigorous verification of his facts. The difference accordingly between knowledge scientific and unscientific is not so much a question of reality as of method. The man in the street picks up his facts, like everything else, just as he finds them, and takes

them to be what they at first appear to be. The man of science subjects his facts to critical examination and logically works them into a system. Science may therefore be defined as ordered, tested, organised knowledge.

Further, it is no just conception of science which claims that it shall be free from error or complete in itself. A scientific investigation, at least in its initial stages, is like groping in the dark, and the scientific inquirer claims the right to feel about in every direction, even if this involves seeming retrogression, and to describe at any moment what he finds, nor be challenged, as if for some moral delinquency, should both his direction and results turn out later to be wrong: for his errors of fact and of assumption sometimes prove to be his best incentives to success, and the way round is often the straightest way in the end. Thus, Oersted's discovery of electro-magnetism in 1820 was the result of his falsely conceived theory as to the effect of a *heated* wire upon a magnet, and the youngest mathematical student adds and multiplies infinities, and works with minus quantities, their imaginary square roots and other useful arithmetical impossibilities.[1] Were perfection an essential attribute of science then should we have no science, nor, indeed, for that matter, anything at all. Suppose that the man of science had all the facts at his command—which he never has—suppose, in addition, that they

[1] $\sqrt{-x}$ is an arithmetical impossibility because there is no quantity which, multiplied by itself, will give a minus product. On the other hand, it has a relation with reality, because it can be used as if it were a real quantity, and "all the laws and relations relating to real quantities can be applied to it" (St. G. Mivart, *The Groundwork of Science*, p. 92). The mathematician, that is, formulates, previous to the employment of such symbols, a system in which they shall play a part, and attaches a specific value to them.

were divinely imparted, yet would there be no infallible way of recording them, nor guarantee that they had been correctly interpreted.[1] Paul's saying covers the whole realm of experience,—"Now we see through a glass darkly." Absolute knowledge science has never professed: nor knowledge of "things in themselves,"—that is left to the philosophers. Her knowledgeis a knowledge of relations,—relations, *e.g.* of co-existence, succession, likeness and difference between things. The greater the number of such relations, the more detailed and the more general such knowledge,—in this consists the growth of science. The unrelated thing, the unrelated fact, is useless: it is useful only in virtue of its relation to other things. The interpretation of the world is simply the finding and understanding of all the relations that obtain amongst its actual partial expressions. The increase of knowledge is not so much due to any new sense-perception or any particular verification from experience, as to a new consistency with an already complex system, which in turn was itself built up out of many preceding alterations of inference from perception. It is important to realise that the facts of science are for the most part "relations": the laws of science are statements of relations found to hold ordinarily under definite conditions. This necessarily gives to Science an abstract character, and inasmuch as these relations are infinite, Science partakes of the character of an endless induction. The same considerations hold also with regard to mental facts, those most certain, if also most variable of all facts. Their inclusion is demanded, for it is useless to attempt to limit Science to objective data only. Pure objectivism may be permissible as a scientific ideal, but it is unrealisable

[1] Cf. F. S. Hoffman, *The Sphere of Science*, p. 13.

in practice, for however carefully we may be on the watch, subjectivism creeps into our data. In certain branches of science the subjective element is most important and demands recognition in any full account of the phenomenon in question, and, in any case, subject and object are united in reality when it comes to intellectual contemplation of the object.

Again, our information with regard to the external world is supplied to us by our senses, whose instruments are of very limited capacity. When we consider the range and power of those senses we become intensely aware of the limitations of human scientific endeavour. Sometimes the fact of this limitation is unwisely emphasised in prejudice of scientific knowledge, as (falsely) opposed to religious knowledge. These limitations of science are, however, the limitations of humanity: they are indeed the limitations of natural science, but in the same degree of psychology, or of theology. Science is not alone in suffering from the inherent imperfections of human power.

Scientific knowledge, then, is human knowledge acquired by what are usually termed the five external senses—in some instances reduced to two,[1]—within the span of threescore years and ten. Further, it is a commonplace of comparative physiology that many creatures from insects to mammals excel us in certain degrees of power of sense-observation. No human eye has the condor's farness of vision: in man the sense of smell is almost undeveloped compared with that of a bloodhound, whose whole recollection of a happy day is in terms of smells. Lord Avebury showed that ants respond to the ultra-violet rays of the spectrum which escape our direct vision: that is to say, they possibly see more colours than we do, and

[1] *e.g.* Helen Keller, the blind deaf-mute: *The Story of My Life*, 1903.

different ones. Indeed, some naturalists concede a sixth sense to insects, while others believe that reptiles have a sense of water, and fish a pressure sense, since either deficient or excessive pressure is dangerous to them.[1] Most of our observations of Nature are made through the eye, yet all objects that vibrate less than four hundred billion times per second, or more than seven hundred and fifty billion times a second, are absolutely invisible to us. The visible spectrum occupies only $\frac{1}{27}$th of the known range of ethereal vibrations. Further, we can see pulsations of intermittent flashes at the rate of six in a second: beyond that number they give us the sensation of a continuous light. It is notorious how the reports of the eye differ with its distance from the object regarded: its powers of accommodation are slight. We alter its relation to the objects that we seek to study by microscope and telescope. In no case does it furnish us with an absolutely exact account. The information is merely relative and the correction is made by that which uses the imperfect instrument, our Reason. One might even say that the faculty of sight in man is not imperfect; it is only the instrument that fails.

Again, although, on the whole, the ear is more discriminating than the eye, we can only hear sounds within a definite range of vibration to the second, beginning at about thirty-three and ceasing over thirty thousand. Beats up to fifteen in the second can be distinctly heard; beyond that they blend into a continuous sound. We hear roughly over a range of eleven octaves, and yet not everyone can pick out the shrill squeaking of the bat: physicists assure us

[1] This is not merely a modification of a sense of touch: for associated with the lateral line—beneath it—is a longitudinal canal provided with peculiar bodies which have all the appearance of sense organs.

that there must be thousands of octaves beyond the eleven. Even the loss of definite mobility in the external ear hampers man in his determination of direction. Finally, with regard to touch, unique amongst the senses in that it can take the place of some of its allies, as, *e.g.*, sight and hearing in the case of Helen Keller, and supreme in its assistance to man as a creator, as all handicrafts testify, we are aware how easily it may be deceived, particularly if tested alone, *e.g.* without the assistance of sight.

Indeed in the ultimate analysis, all our sense impressions are found to be but perceptions of molecular motion. Touch, hearing, and sight are instruments by means of which the living body becomes aware of different rates of motion. How fundamentally akin in operation these different instruments are may be gathered from the following illustration: "In a darkened room, where a steel disc quivers ten to twenty times a second, the finger is sensible of a vibration; if it moves sixty-four to thirty-two thousand times, the ear hears a note more and more high-pitched; if it vibrates still faster, the finger feels warmth and next heat; after four hundred and fifty billion vibrations per second, the eye beholds a reddish glimmer, growing lighter with every acceleration of the motion of the molecules, and terminating in a white incandescence comprehensive of all colours whatsoever. We may accordingly say that the ear sees the sound and the eye hears the light, and it is a conceivable possibility that in other beings than ourselves a single organ might be able to perceive the foregoing molecular motions successively as a mere intensification of the same sensation, or as a kind of modulation of shades of a *single* colour."[1] The

[1] Prof. F. Bettex, *Modern Science and Christianity*, p. 74.

illustration seems to involve change in the character of the media of vibration as the passage is made from sound to sight, yet air is ultimately explicable in terms of ethereal motion: the real discrepancy is between the ethereal vibrations and the sensations produced in the brain. It further implies change in the character of the vibrations as these pass from vibrations of the mass to motions of its constituent molecules. Yet it may be taken to show very clearly the division of labour that has been achieved amongst the senses. Each of them covers a certain limited stretch on the vibration scale, but between them all, it is only a very small portion of that range that is so covered.

Consider then that on our planet there are numberless objects with which it is impossible for us to come into relation simply because of our physical constitution, and that of those objects of which we are aware it is only with some few aspects that we can become acquainted. This conception of a world beyond our senses at once supplies us with an area of momentous possibilities. We lack entirely a sense for electricity, being unable to distinguish between positive and negative electricity; were we so endowed, a new world would dawn on us and Science. Think of the world without the sense of smell,—how completely we should have been lacking in suspicion of the variety of flavours and perfumes. Of these sense-limitations man is keenly aware. Other animals are similarly endowed, some better and some worse, yet there is no sense-discontent within their lives. Man alone is aware of a failure of correspondence between his faculties and the bodily instruments with which they are equipped. These defects he seeks to remedy and thus enlarge the exercise-yard of the spirit within: nevertheless it is still confined within the prison of the

human frame. Small wonder that it should reconstruct for itself in imagination some other sphere of existence where, with instrument worthy of faculty, things would be seen and heard and known as they really are, without the distortions involved in space and time. Paul speaks of what "eye hath not seen, nor ear heard, nor hath entered into the heart of man to conceive,"[1] as prepared for them that love God. But this involves a corresponding preparation in those who would receive the revelation, and we may dimly perceive how great must be the change before an individual attains that perfect comprehension of Ultimate Reality and correspondence with it, in which the joys of a future state must so largely consist.

It would therefore seem as if that particular sense construction of the world that is ours is relative to the capabilities of our senses.[2] We may suppose that to beings with acuter senses reality would appear otherwise, would be more completely known: even the so-called properties of matter might wear another guise. An additional sense might give us a very curiously expanded conception of the world. That particular conception which we have attained is suited to our abilities to comprehend—in fact, it is the direct result of them. Further, that conception has evolved throughout the ages. There is a continuous unfolding of reality to the human mind, and it becomes increasingly realised as spiritual even on the physical side. Such a view involves no Kantian dichotomy of reality; the real and the ideal are but different aspects of one and the same thing. From the divine viewpoint our helpless contrasts of spirit and matter, of natural and supernatural must be strangely non-

[1] 1 Cor. xi. 9.

[2] Cf. J. H. Newman's *Oxford University Sermons*, p. 347.

existent. They may testify to the incompleteness of our conceptions; possibly they are relative merely to the particular stage of development. Certainly they can never establish that these conceptions are mere delusions.

Subject to such limitations, science cannot and does not deal with absolute certainties: at best she replaces the more uncertain by the less uncertain. Such has been her mission throughout the ages. She is always provisional; she can never be final. Indeed, Boutroux goes as far as to call science "the hypothesis of constant relations between phenomena."[1] The sphere of certainty can only embrace those ultimate self-evidencing intuitive intellectual perceptions and allied principles of reasoning without whose assistance the quest for knowledge or the demonstration of irrationality in things are alike vain. All else, all other data and all generalisations from such data, lie within the sphere of the probable. Nothing is easier than to show that all the generalisations of physical science are probable only:[2] the same is true, though not so obviously, of her facts. And yet every statement that the man of science makes concerning some object that is external to him is an induction, and as such can only be probable, except on the basis of his mind being infinite and his judgment infallible, and so capable of perfect knowledge. An astronomer observes a star through his telescope. He is certain that he experiences a sensation of sight. He is likewise certain that he, experiencing that sensation, exists, and that there is a cause for the sensation. From all the data that he can gather he infers that the star is the cause of the sensation, but strictly he can never know

[1] E. Boutroux, *Science and Religion in Contemporary Philosophy*, p. 244.
[2] Cf. W. S. Jevons, *The Principles of Science*, chap. x.

with absolute certainty that his solution is correct. Aided in every possible way, his knowledge would still remain probable, highly probable if you will, for the degree of confidence will naturally vary with the degree of probability, but not strictly certain. Even in the exceptionally clear science of mathematics the old-time claim of absolute truth for its propositions is gradually giving way to an unassailable but infinitely more modest claim of consistency. No mathematician in the world knows whether the sum of the angles of a triangle is equal to two right angles or not. The statement is true in the case of the Euclidean system of postulates and deductions. But that is not the only system, and others just as consistent are conceivable in which the sum of the angles is greater or less than the Euclidean figure. Absolutely certain knowledge is no product of inference: in origin it is direct, intuitive. The data of natural science lack these characters; they are always derived, indirect, inferential.

It hardly needs to be added that the probability of things lies not in Nature but in our minds. The degree of probability is an index of the degree of knowledge. Nature, we assume—otherwise all motive for scientific study would be gone—is a rational process: whatever happens takes place in accordance with principle and order. There is nothing capricious in Nature, nothing uncertain about her activities in themselves, but there is a marked shortcoming in our understanding of these activities. That understanding takes the form of those statements of relations between facts, commonly known as "laws of nature"; but a law to be complete would need to cover every relation and every fact: yet every relation we do not and cannot know, still less every fact. Accordingly such state-

ments (laws) are probable only. The uniform denial of the probability of knowledge could only follow a claim to omniscience and therefore to infallibility. Knowledge is a considered *résumé* of higher-grade probability.

To speak about our knowledge of physical science, then, is really to state our mental condition with regard to it, and this, like every human activity, ultimately rests on the theory of probability. As a matter of fact, our lives in every aspect are one long conscious and unconscious peradventure. We eat food on the probability that it will nourish us; we take the car in the probability that it will carry us to our destination; we visit our physician on the probability that he can aid us; and we arrange for to-morrow's work, because with some things if not with someone we have learned to associate continuity.

It will follow in every department of learning, that it is never necessary—since, in fact, it is never possible—to do more for any proposition than to show that the balance of probabilities is in its favour.[1] The final claim of any fact, of any doctrine, to recognition is its reasonableness, and this we establish by carefully weighing the statements made about it, and accepting or neglecting them according as the balance of probabilities is for or against them. When we have done so, we are perfectly justified in adopting that proposition as a doctrine of science or a rule of conduct. It is only in proportion as we thoroughly "test all things" that we develop the instinct to appreciate and the power to "hold fast that which is good." And if at times we are apt to be oppressed with the feeling of uncertainty in the round of human existence, we shall be helped in holding on our way more steadily when

[1] Cf. Hoffman, *op. cit.* p. 30.

we clearly grasp the fact that in this universe in which we find ourselves, "only he who is willing to walk by faith can walk at all."[1]

It is important, however, to note that in addition to these natural limitations, science often imposes upon herself artificial limitations, and there is a sense in which scientific knowledge has value only in proportion to these self-imposed limitations. To honour science is to respect her self-imposed limitations. To decry her "narrow outlook" is to fail in appreciation of her value. For she can only make progress in so far as she definitely confines herself within certain clearly marked limits and rigorously excludes everything else. The chemistry of sugar has in itself no direct relation to diabetes or other problems of animal or vegetable pathology and physiology; it simply analyses the substance sugar and considers the relations and proportions of its elemental constituents. The value of a science is in proportion to the degree in which it strictly limits itself to the special set of characters it proposes to investigate. And the same holds true of Science in general. Much of the confusion that has from time to time arisen in consideration of the relations of scientific and religious thought is due to the fact that, after having made certain limitations in order to reach certain conclusions scientifically, men have proceeded to apply these conclusions far beyond the limits that were imposed in order to reach them.

The chief danger, however, in all scientific procedure lies in the possibility that after having studied a series of phenomena under his self-imposed limitations the man of science is sometimes tempted to imagine that his account thus acquired is the whole story, and so to remain oblivious to other significances and inter-

[1] W. N. Rice, *Christian Faith in an Age of Science*, p. 409.

pretations which are, at any rate, just as valid, and which must enter into any complete account of a phenomenon. Of the autumn colouring of leaves, the botanist will give a wonderful account in chemical and physical terms—a series of changes induced initially by a difference in temperature and the gradual breakdown of certain cellular constituents of the leaves. But are we therefore entirely to disregard the æsthetic appeal? Not so, if the objectivity of any phenomenon includes its social relations as well. Darwin explained in a remarkable way the coloration of plants and animals on the principle of utility; but of what advantage to the tree are these flaming reds and gaudy yellows? "Nature," says Mozley in his *University Sermon* with that title,[1] "in the very act of labouring as a machine," in virtue of the same laws, "sleeps as a picture"; and the one aspect is as true as the other. The internal changes in the variegated foliage of autumn have significance both for the tree and for the man of science in his endeavours to express their life-history in terms of physics and of chemistry; but correlated with these are external changes which make appeal to another aspect of man's being and which must be included in any complete account of the forest. In considerations such as these we become aware of the incompleteness of a purely mechanical interpretation so far as it professes to deal with the total significance of phenomena.

It is perhaps to-day more than at any other time peculiarly important to have a clear conception of what it just is that science can do, what exactly is the worth of scientific knowledge. The appeal of science is to experience, which at once limits her accounts in a very real way. Of origins she can give

[1] P. 123.

no experiential account: it is questionable if the category of ends comes naturally within her sweep as pure description, and to final ends she can bear no witness. The highest ideals for which men strive are not those that we win from science, although in matters like eugenics she may give substance to them; science may give us an ideal of accuracy, but not yet of duty. The strictly scientific fact—*i.e.* one which can be expressed in terms of measurement or in some physical aspect only—is only a part of reality. There are facts and facts, and justice or goodness or the consciousness of them are facts of which an account must enter into our description of reality; and they are more likely to influence the scientific fact than *vice versa.* The strictly scientific aspect is the objective, that which can be reduced to figures and which has a relative stateableness. It is an aspect, further, the account of which, studied and accurate though it be, covers no more than a hundred years of a process that has synchronised with time itself; it has broken in, so to speak, at a certain stage, late in the day. As if some pageant had been in progress since the dawn of creation, and the descriptive reporter had arrived late on the scene. He may guess what has preceded by certain features in what remains; he may surmise that there is a *dénouement*, but strictly, *qua* man of science, he does not know.

Again, this process is so involved and intricate that we can be perfectly certain that at no single moment of it do we get an accurate and full description. It is proposed to find out how any particular portion of the pageant is mechanised, but there are so many factors involved that the problem in itself seems insoluble. Accordingly, it is stripped as far as possible of certain features; it is reduced and simplified, and

then a statement is offered. But this statement represents only an aspect—indeed only an aspect of an aspect; never is there any direct touch with reality.

The farther science proceeds in her ideal, abstract representation of phenomena, the farther she gets from reality, which is infinitely more complicated than the network of laws that comprise that representation. The relations of any single fact are infinite, and science is closest to reality when treating of the relations of that single fact. At the same time in proportion as she attempts to form a picture of the infinite relations of infinite facts is her grip upon any particular bit of reality rendered less effective. At the best she offers, in a now familiar simile,[1] a linear succession of juxtaposed cinematographic pictures which, as so many external snapshots, fail in their expression of that which from the inside takes the form of a continuous developmental process. As Professor L. T. More puts it,[2] "Science, in other words, like philosophy, has no ontological value."

Such conclusions are likewise not wholly unconnected with those limitations of the senses to which reference has already been made. What we perceive, to take but one example, are not realities. We never see things as they are, but as they were. All sight depends on the definite rate at which light travels. With very near objects, the difference is very minute, but still calculable. The moon is 240,000 miles away: we cannot therefore see her as she is, but as she was one and a quarter seconds before. Some of the fixed stars we perceive by light rays that left them about the time of the birth of Christ. Again, the study of

[1] H. Bergson, *Creative Evolution*, p. 322.
[2] *The Hibbert Journal*, vol. vii. p. 881.

physical science—and increasingly of biological science—is statistical: it deals with averages. Therefore the scientific account of any phenomenon is in the last extreme but a skiagraph, a more or less correct but shadowy outline of some portion or manifestation of that Ultimate Reality, which we can never hope to fathom completely. Reality may be something that obeys the scientist's abstract network of law at a certain point and to a certain extent, and yet is something greater than law, greater than all his explanations of it. But to have learned this is to realise that there is a point at which his methods break down, that it is just possible that truth may have been revealed in more ways than one, that the achievement of knowledge implies moral as well as intellectual qualities, that after all it is not to the clear-sighted nor to those of a far vision that it is given to behold Ultimate Reality—to see God—but to the pure in heart. Whence arises that spirit of humility without which it is impossible that any man, learned or unlearned, may enter that Kingdom of Truth which has as capital the City of God.

Such being the case, the hoary antithesis between Science, *i.e.* Knowledge, and Faith proves not to be so derogatory to the latter as it was once supposed to be, and with the recognition of this fact disappears much of the occasion of these old-time conflicts between Science (representing, as was supposed, unalloyed certainty) and the Faith (as representing a distinctive form of doctrine with a more or less nebulous basis of fact). In any case, the so-called warfare between Science and Religion was never a clash of facts, although it often was a tourney between definitions. But what we may have—what, in fact, we do have—is a scheme of, *e.g.*, chemical knowledge, and a scheme of

religious knowledge, in both of which faith plays an important and vitalising part. Chemical knowledge and religious knowledge are alike based upon facts of experience, but in the shaping of that experience faith equally plays a part in either case. To the religious mind faith is usually "the substance of things hoped for"; to the scientific mind much more immediately it is in large measure "the substance of actual existing things."

For all scientific knowledge is based on such stupendous yet perfectly natural assumptions as the uniformity of Nature, the universal validity of the Law of Causation, and, we might even add, the objective existence of the external world as distinct from our sensory perception of it—assumptions which Huxley himself admitted [1] could not be proved by the experience we had of them, nor indeed by any amount of experience. How then does he dare to accept them? "It is quite true," he says, "that the ground of every one of our actions, and the validity of all our reasonings, rest upon the great act of faith which leads us to take the experience of the past as a safe guide in our dealings with the present and the future." [2] Science, in short, is a linkage of data dependent on faith in this uniformity hypothesis.

So characteristic an attitude, so basal and omnipresent an intellectual activity as that of faith challenges inquiry as to its origin. Possibly it is simply a reflex of a feature of the race, namely, that spirit of trusting adventure, often with little to justify it, that has been the mainspring of all progress, mental and material.[3] It was a Lamarckian principle that new needs induced

[1] *Evolution and Ethics, and other Essays*, p. 121.

[2] *Science and Christian Tradition*, p. 243.

[3] Cf. Prof. J. Ward, *The Realm of Ends*, p. 415.

new organs: it is a question whether the generalisation should not be more sweeping, and a new need not be merely the cause of every modification, but of every aspiration. Had there been no mutual reaction in the sensitive epidermis when first in the presence of light rays—no incipient "will" to see, no "faith" to follow the gleam—the eye had never been developed. Had there been no mutual reaction in the sensitivity of the human mind first aware of the influence of a spiritual world, there had been no discovery of God. Faith is the giving substance to things hoped for: it drives us into action. It represents an effort, an outpush in a certain direction because of a felt want. This self-committing venturesomeness, this launching of our minds in a specific direction, is the most fundamental act in all human nature. Without it there could be no experience, no acquirement of knowledge, unless as by a recording cognitive automaton, dwelling in passive sense-perception alone. Faith is the great necessary prius of all endeavour: out of activity and effort consciousness has arisen. Faith is the yeast in the raw material of knowledge; it can be transmuted into knowledge through experience, and this in turn stimulates faith. There is no such thing as pure knowledge; it is always an alloy. No coin is pure gold—it would wear away; pure knowledge would be unpractical. And faith can never die because of that subsequent progressive verification that is its inalienable accompaniment, particularly in the deepest things of life. It is an instinctive attitude of demand for self-substantiation, that, irrespective of probability, is maintained towards whatever for any reason seems to have the possibility of self-justification and verification.

Faith thus exercised scientifically assuredly gives us a conception of reality that is as inadequate as the

conception of God that results from the religious exercise of faith. Yet we can see the great progress in both views even in the span of the Christian era. The contention is that the faculty exercised is essentially the same, and that ultimately it is exercised upon the same object, although upon different aspects of that object, and in different degrees. The faith that is involved in all knowledge is man's nature going out towards that in the universe which secures his place in it. The faith of science and the faith of religion are alike justified as conveying some knowledge of Reality. The greater uniformity in the results of scientific faith compared with those of religious faith is in no way prejudicial to the latter. Even in the case of the former, where the determinations are most subtle, whether in that exercise of the senses or the mental treatment of the results so won that go to form the pabulum of faith, the uniformity is by no means so general, and agreement does not necessarily mean that the judgment reached is true, or rather not largely relative. In a greater degree more subtle, refined, and sensitive is that exercise of the faculty of faith in the winning of the secret things of God. And while a consensus can only establish that to which there is general consent (and even this only problematically), it can never suffice to disprove any particular achievement. Of any thirteen people in a cave probably not more than one will hear the shrill squeaking of the bats which all can see or feel fluttering around. The consensus of the majority that no sound is audible does not invalidate the testimony of the one who says he hears a sound. The majority are alive to many aspects of the bats, but there is one individual who can give a more complete account than all the others.

Yet man is not completely man merely when he knows, or consciously exercises that will to know so intimately associated with the evolution of faith, which, fully developed, is the inspiration of every form of higher activity in the self-conscious being. In intercourse with Nature feelings are aroused which incite to further knowledge, and knowledge in turn plays in different ways upon our feelings. Now any account of a phenomenon in terms of science will appeal to our intellect; but the phenomenon, even the account of it, may appeal to one of these other aspects of the human constitution. And without the inclusion of these other aspects the account is incomplete. The scientific account may be complete, but that is not the whole account, and in certain cases may be the least satisfactory or important part of the account, *e.g.* in the case of a rainbow or a sunset. From such instances it is not a far step to those other circumstances and events that appeal to and control the destinies of man. There is no ultimate difference in kind between the appeal of the radiance of the rainbow and of beauty of character as it appears in some human form.

It is but a further step to consider that that controlling, moulding, appealing agency may sometimes have at the moment no direct relation with the external world: it may exist simply as an ideal. Yet it may be doubted whether any ideal has ever entered the human mind as it were out of space, *e vacuo*, unrelated to anything else in the world. Not merely, therefore, must all idealistic impression connected with any phenomenon be taken into account before we can in any way call our account complete. That ideal itself, connected both with the will and with feeling—for an ideal is that which commands the assent of our will

and evokes approval—is as much, when entertained, an affirmation as any piece of intellectual knowledge. Our recognition of an ideal is an assertion of its approval by us; it is therefore a matter of knowledge for us,—knowledge, let us say, about the conduct of life, —and as such not different in kind from any of those views about the physical world that pass for knowledge. And further, every human action as the result of the exercise of will is likewise just such a voiceless assertion: activities, like things in general, are because of their significance.

Accordingly while that interpretation of phenomena as they are, have been or will be, which corresponds to the scientific account of things—the real as it were—is valid, yet it is not the whole account, and this is furnished by also considering the ideal—that is phenomena as they exercise influence over or can be influenced by the human will or emotions. Indeed from the plane of human life the latter is by far the most important, for the will to know has its roots in a desire to master the world and make it approximate to what our feelings would have it be. Self-conscious life is a struggle first to decide what ought to be and then to bring that into effect. In this sense the real ministers to the ideal: Naturalism is no competitor with, but is the servant of, Idealism. Naturalism is true, but it is an incomplete interpretation of phenomena: it is as if a man explained a picture in terms of chemistry and physics and the painter's palette.

Of this incompleteness we find a hint in the particular scientific conceptions themselves which on thorough examination are found, as Boutroux expresses it, "to point beyond themselves."[1] It is not the doubts ex-

[1] Boutroux, *op. cit.* p. 262.

pressed as to the absolute truth of the conservation of energy:[1] it is that when we examine the latter conception itself we find ourselves driven beyond the purely quantitative (and therefore measurable) aspects to others where this criterion will not help. For these measurements will embrace changes in the physical nature and composition of that which is the vehicle of energy,—changes, that is, also in the form of phenomena, and that form is something more than a mere name for a condition or particular collection of measurements which apply to certain aspects only. The same holds true of the scientific ideas of Life and Evolution. Science is continually hinting at that region wherein the religious consciousness finds its satisfaction: her accounts in proportion to their completeness rise in their dignity, their wonder, their power.

Between the conclusions of Science and of Religion there can be no occasion of conflict. In their most characteristic types they have little in common: and in that basal region where they come together, disagreement is out of the question. They do not treat of different planes of phenomena, nor deal with absolutely unrelated series of facts. They are concerned with the same kinds of facts but in different ways. They deal with the same world, but ask and answer different questions concerning it. Science is concerned with the order of events in causal association with similar events; Religion considers events in their infinite relation to the sum total of events.

In her account of things Science has still these very things to account for: in her use of mind as an instrument, she cannot forget that without mind her existence would not be possible. Over and above

[1] Sir Oliver Lodge, *Life and Matter*, p. 22.

the symbolical account of external reality there is the mind that appreciates it. Phenomena can have no extra-mental existence though they may well have an extra-human existence. In truth Science corresponds to but a single aspect of Being, and she cannot maintain that the part with which she interests herself is equal to the whole. In man there are other needs, other driving necessities than that imperious demand for unity that instigates his scientific quest.

Religion has her great mission, that of enabling man to overcome his surroundings and himself and to acquire that peace of spiritual content that will give him the victory over disquieting doubt and temptation: and in all this Science can help—Science in so far as she is truth, for it is the truth that sets men free from the prison of their fears. But Religion can never be Science, and still less can Science ever be Religion. Religion deals with the supernatural, it is said: but the supernatural is concerned with the whole world. We talk of the real and the ideal, different aspects of reality: but the natural and the supernatural stand to one another in an analogous relation. And our interpretation of the real is modified and governed by our interpretation of the ideal.

To-day the theologian and the man of science can meet and find that they share in a great community of belief. "Religion," said Sir E. Ray Lankester in a Presidential Address to the British Association for the Advancement of Science—quoting from Bishop Creighton—"means the knowledge of our destiny and of the means of fulfilling it;" then added, "We can say no more and no less of Science. Men of Science seek, in all reverence, to discover the Almighty, the Everlasting. They claim sympathy and friendship

with those who, like themselves, have turned away from the more material struggles of human life, and have set their hearts and minds on the knowledge of the Eternal."[1]

[1] Presidential Address, *Brit. Ass. Report*, 1906, p. 42.

CHAPTER II

THE INFLUENCE OF SCIENCE UPON RELIGIOUS THOUGHT

THE history of the relations of scientific and religious thought,[1] so full at once of instruction and of tragedy, discloses no period in which the influence of the former upon the latter has been greater than during the past sixty years, fitly designated the Age of Science. This influence has increasingly manifested itself in three distinct ways. It is seen, directly, in the modification of religious doctrine as the result of definite scientific conclusions. Men have got into touch with Nature, have learned her order and her laws, and so far as they have seen in them the divine method of operation, have formed more worthy views of the World-Principle of which Nature is a partial expression. Our conceptions concerning man and "the Fall," the relations of sin and death, and God and the world, are not those of mediæval times, not even those of our grandfathers, —or ought not to be. In each case a great deal has been definitely added, and what was already there has been purified and clarified. The definite increase and modification are due in great part to the advance of scientific knowledge. Nor has this advance resulted in the disproof of any essentially religious truth. Facts

[1] *cf.* J. W. Draper, *History of the Conflict between Science and Religion*; A. D. White, *Warfare of Science with Theology*.

cannot prove a negative. There are millions of stones in the world that show no spontaneous attraction: but that does not invalidate that other fact that the lodestone attracts iron.

This influence of Science upon religious thought is further manifested in the widespread adoption by religion of the scientific method. The scientific method is, briefly, an appeal to experience and to experimental tests on the one hand, followed by the induction and enumeration of general laws or principles as the result of this appeal. The data are carefully recorded, verified, worked over and collated, until the personal element is winnowed out and the residuum of abstract truth is left. In her collecting of well-attested data and sifting of evidence, Science has given us an ideal of exactness and has disciplined our thinking. This may be illustrated in various ways.

(*a*) In the detailed discussion of any important question, the historical method is now always adopted. The thing as it is can only be fully understood in the light of its history. Science has long known the value of the examination of life-histories, and theology has applied this method to the elucidation of her organic entities, *i.e.* her dogmas—for if any of them are not living, they had better be discarded,—with conspicuous advantage. Or the investigation may be more radical. Starting from the religious consciousness, we may strive to determine the question of its universality, or what is more difficult, to reach the permanent and unchanging element in its witness. Each age has had its theology; perhaps each individual in any age has his. How much has it been coloured by the particular ethos and atmosphere of that age? That it has been so tinged nobody will deny. There is the hereditary element, reproduced because it is something living, but there is

also the increment due to the pressure, social and intellectual, of the particular period. Can these be successfully disarticulated from the original growth, so that we could, working backwards, gradually unstrip the sheathings of each era, like the enclosing leaves of a bud—each of them in some measure alive—till we come to the vital core? The suggestion of such investigation implies the application of a method that is essentially scientific.

Such naturalistic examination is often, however, feared, particularly where it affects to give accounts of the origin of distinctive human characters, such as mind and conscience, that are felt to be derogatory to the characters in question. Yet even if we can successfully give a correct naturalistic account of the rise of the distinctive human characters, the fact remains that we are dealing with a world that harboured such possibilities, and it is difficult to avoid the conclusion that these characters point beyond themselves, and are never *explained* in the fullest account we may give of their history. Why, for example, if we may do as we like so long as we grin and bear the consequences, should such an inhibitive sense ever develop as that of moral obligation, if it did not bear witness to something beyond itself? There could have been no inducement to follow its beckoning in the case of those who had the first experience of its call to self-sacrifice, and perhaps death, because they could not have *known* that it would eventually mean life in greater abundance. They must have felt that the call had relation to some external circumstance, perhaps even to One calling: they must have obeyed, penetrating beyond the challenge "Ye shall therefore be holy, for I am holy."[1]

Again, it is by the aid of this method that the

[1] *cf.* R. H. Hutton, *Synthetic Society Papers*, p. 32.

science of Comparative Religion has been developed. As a result, we now see that all religion, not excepting the religion of revelation, has had a history, that that history has been continuous, and that its successive forms should be investigated in their mutual relations. We may learn how very diverse national and tribal sheathings have protected living cores in no great way dissimilar. Thus we have been led to the recognition of something useful in the world-religions, to the recognition of the fact that they had a function to perform, and that they exerted a wonderful moral influence over men—positions that had not been reached some fifty years ago, views that are the direct outcome of the evolutionary attitude. As a result we are compelled to realise how we must henceforth *think* Christianity always in relation to the whole world, not merely applying it practically to the world's need, but also stating it intellectually in its adaptability to the gropings of many pagan minds, and above all saving it from being elaborated merely into a code of Western ethics and ritual.

(*b*) The scientific method has likewise resulted in the application of increased powers of observation and analysis in that sphere where we are considering its action. This has involved a clearer appreciation of what is implied in a demonstration, the bringing of cause and effect into more marked relief. It has also meant that an increased number of factors—secondary causes—is looked for as the explanation of phenomena in the religious as in the natural world. In one sense this is to recede from the standpoint of the Hebrews, who had little idea of secondary causes and to whom God was immediately back of all phenomena. "In the beginning God created the heavens and the earth," and in their opinion He acted in the same direct

manner all along. This is essentially the religious idea. But, on the other hand, ours is the gain in knowledge of the marvellous ways of His working; progressively, Kepler-like, we may sometimes be conscious of thinking His thoughts. On this view, involved in the very possibility of knowledge itself, Science is but the unfolding, the revelation of the thoughts of God which it is our privilege and duty to try and follow Him in thinking. It is scientific method that compels us to read our knowledge of nature into our interpretation of Scripture, in place of the older method whereby Nature was interpreted by traditional conceptions of Scripture.

(*c*) Again the scientific method is mainly responsible for the present-day critical tendencies that are at work in every department of knowledge. The conclusions of past generations are questioned, examined, refuted, or rehabilitated. Formerly, men were well content to accept statements and facts, theories and solutions on the strength of a great name or institution. To-day that is all changed: our age no longer pays implicit respect to the authority of authority. This does not imply a revolution—the abolition of authority. As knowledge grows and civilisation advances, man has to accept more and more upon authority. He thereby frees himself from his own limitations, and in such acceptance signifies his recognition of special training, special insight, perhaps even special communication. Such massed authority, as representing the supreme pronouncements of the human mind, merits allegiance. Yet the recognition of authority does not mean that the individual is to use his own reason less. On the contrary he must use it more. Whatever the dicta of authority, they have to be justified, and that can only be done at the bar of

Reason,—a Reason that becomes increasingly capable in its particular business. Authority can never be a substitute for the individual experience; it should not supplant but rather supplement it. In that spirit which considers no name too great, no reputation too high to prevent the statement or hypothesis lying under its shadow from being dragged out into the fierce light of modern expert criticism, we may see the influence of the scientific method upon religious thought. The compulsion of truth sometimes looks like sacrilege, and it is just here that the scientific method is especially helpful in its insistence on the preservation of an open and impartial judgment towards subjects still under debate. If the judgment is adverse, the scientific worker discards his cherished ideas, even although sorrowing, for the sake of truth; and if substantiated, he embraces them again with the joy of recovered treasure. Now there is probably no field of human inquiry where a greater mixture of essential and non-essential has accumulated than just the general field of religion. And surely there is no sphere where sharper distinction should be drawn between what is known and what is inferred, between what is and what seems to be.[1] The influence of the scientific spirit is seen in the stripping off all round of non-essentials, in giving them their right value, and adjusting them to truths more newly won. The natural theology of one age fails in its appeal to a later age. The piety of Paley still impresses men, but not his premises or proofs. For not merely has Nature changed, but what is vastly more important to us, our understanding of her has changed even more. It could hardly be that the old appeal should hold. Any such spirit of inquiry need not be feared, for, in

[1] Prof. J. M. Coulter, *American Journal of Theology*, vol. iii. p. 645.

the language of the unknown writer to the Hebrews, it merely "signifieth the removing of those things that are shaken, as of things that have been made, that those things which are not shaken may remain." On the contrary, it is a movement to be welcomed, for it is at once hopeful and necessary; so much so that even of those regions where its work has been most radical (as *e.g.* Old Testament criticism, where it may leave us as a result with but a portion of a book conforming to our earlier opinions of it), we can say fearlessly and truthfully, though mayhap paradoxically, —The half is better, greater, than the whole. Yet even all such questions seem petty when compared with the question to which the practice of the scientific method ultimately drives us—What is it that finds itself in constant reaction with Nature, and insists on a renewal of expression, dissatisfied with the elaborated testimony of a previous age?

In this connection, scientific procedure suggests in analogy an influence that may yet be more definitely exerted. Of nothing is science more proud, on nothing is she more dependent than her experimental method. Experimental Religion was a word of our fathers containing a truth which is ever being realised afresh, —practical experience of the power of religion on the individual life. Experiment differs from mere observation in that the observer instead of merely waiting for favourable conditions, as *e.g.* the astronomer and palæontologist are compelled to do, himself in great part arranges the conditions of the phenomenon of which he desires experience: others of them are arranged for him in the fundamental laws of nature. A good experiment is one which teaches us more than a single isolated fact, one which enables us to predict, to generalise, for without generalisation prediction is

impossible. Religious experience, no less than any other kind of experience, may be acquired under conditions that lend themselves to arrangement and repetition. Concerning these conditions the learner can only go to those who have already made experiment. For if there is an experience in religious matters as well as in things secular, and if in the case of the latter we go to the expert for information and for stimulus, then it would seem to be the wise and proper course to seek out the men of moral genius, and from them learn the best that they can teach us. How can a man otherwise begin to understand that for which he has no initial affinity? And if it appears that such experience culminated in One who more than any other claimed to know the mind and will of God, and has proven Himself to be such by the inspiration of His life, then it would seem the height of folly to disregard His teaching and to refuse to learn of Him.[1] Now that teaching is above all things experimental.[2] In many instances it consists of definite assurances of results provided certain conditions are followed,[3] and the predictions and generalisations of the most competent experimenters have been throughout the ages a source of joy and encouragement to themselves and to their fellow-men.

The influence of Science upon Religion may lastly be seen in the gradual growth of an atmosphere, an attitude of mind, which may be called the scientific temper in Religion. This naturally results from use of scientific methods, but in differentiating the two we imply something more subtle and difficult of definition. The breadth of outlook, the hankering after causality, the desire to test all things and hold to that which is good, the freedom from dogmatism, the patience

[1] *cf.* Wilfrid Ward, *Synthetic Society Papers*, p. 19.
[2] *cf.* John vii. 17. [3] *cf.* John xv. 7, 10.

under mental tribulation, the perseverance in the face of temporary failure and defeat, the wistfulness that will yet ponder for years over an apparently insoluble problem, the determination that again and again traverses the field of the known to verify or pick up some grain of knowledge that has been overlooked, the sympathetic regard for his brother's travail, the secret and immovable content with the universe, the firm assurance that it is sound and solvent at the core—it is in traits such as these that we may, and increasingly do, recognise the scientific temper in the religious man. But most specifically may we think of that spirit of adventure without which Science could not enlarge her borders, and through lack of which religious life has stagnated not merely in many an individual but even in whole communities. Few great scientific discoveries have been made directly and immediately; for the most part they have been the result of accident, by-products of some intellectual and experimental enterprise that definitely set out in another direction. "The process of seeking out analogies and resemblances wisely," says Mivart,[1] "is perhaps the special characteristic of a sagacious man of science." Very often the man of science is as a fisherman throwing out the bold line of his hypothesis or speculation over some region of the river of experience that flows continually by him. He has reason to believe that there are fish in that particular stretch; someone else has got a fact or two out of it. And he throws out his line, but the fish are not amenable. He then alters his hypothesis,—changes his fly as it were,—and after repeated attempts and days of patient endeavour, during which he finds that none of the accredited flies are of value, he makes up that particular

[1] *The Groundwork of Science*, p. 96.

new fly that compasses his facts,—he enunciates the hypothesis that fits and suits the facts so that he can, as it were, control and draw them in to his side. Now, in the religious life is there not, or rather should there not be, something very like this? How else can we describe the feeling after God in all generations, if haply they might find him, this setting of the soul in a particular direction? Even towards that revelation which was given in Jesus Christ of the loving Father heart of God and of all that concerns His relationship to the sons of men who are His children, a man could adopt no more fitting mental attitude; while the humble but adventurous and expectant soul that does the will of God will find fresh knowledge,—not merely knowledge that is already the experience of others though new to itself,—but absolutely new knowledge pouring in on every hand concerning—to take but a single example—the nature of God, who does become known to us in certain of His attributes as an evergrowing revelation. To "follow on to know the Lord" is a supreme duty as well in the interests of man's thought as of his soul.

If in concrete illustration we might endeavour to imagine a scientific man at work upon his creed, assuming that he has the will to believe or the will to doubt, or at any rate is not disposed to regard the theistic attitude unfavourably, we may be sure that he will begin by telling us that no thinking man begins with a creed; he arrives at a creed. He will also tell us that he is not afraid daily to re-examine critically his creed; science waits no three hundred years for œcumenical revision. The man of science believes nothing to-day in the strict realms of science that he is not prepared to surrender to-morrow, should sufficient reason be shown. He will further lay stress on the fact that religious, and more particularly

theological, thought is tinged—perhaps a stronger word should be used—with anthropomorphism. That, of course, cannot be helped; it is, so to speak, part of the rules of the game. But he will insist that we be thoroughly conscious of this anthropomorphic bias, and set some check upon it. He will also have us definitely recognise that ultimately we are all agnostic in a sense. God is unknowable in the exhaustive sense. The man of science will tell us all he knows about his department, and then he will take Job's words and say, "Lo, these are but parts—the outskirts—of His ways; and how small a whisper do we hear of Him! but the thunder of His power who can understand?"[1]

He will also, in his honesty, probably let us know that there are certain moods,—although a mood in itself is never a philosophy—certain environments, in which he would find it easier to entertain a theistic interpretation than in others. Men do not believe equally intensely all the time. There are differences in the degree as well as in the range of men's faith, religious or scientific. Of some things they are more sure than others, and many are the influences, including sometimes even the infectious strong faith of another, that cause these differences of degree. He will ask you to read such a book as Maeterlinck's *The Bee*, or wander through the streets of earthquake-stricken Messina, and then try and do a little theistic thinking. God, if the Nicene Creed is right, is responsible for the bee community—for those features that shock our moral sense no less than for those that excite our wonder. All things are ordered by the divine Thought or Will or Reason, and in that bee community we see a part of the divine economy. There He is working and realising as in the circuit

[1] Job xxvi. 14.

of the planets, and in the hearts of men. For what are God's works of Providence? In the words of a famous catechism, "God's works of Providence are His most holy, wise and powerful preserving and governing all His creatures and all their actions,"—*all* His creatures and *all* their actions—the plesiosaurus of other days, you and me and the bee. We can divine in part, and we can believe; nay, are we not apt to let the rest of the redemptive system outlined in Scriptural Catechism obscure our appreciation of this central truth—the broadest generalisation of them all—if it be true—that God is exercising a continual providential, a holy, wise, and powerful governance over the lives of all His creatures? But we must not shut our eyes to facts, and such an incident in the social history of the bees as the yearly massacre of the drones gives us something to think about. There is no doubt that everything is apparently run on a system of monstrous waste, and we have got to try and find a rationale of it. We can imagine that things might have been otherwise. Such imaginings are our ideals, which, unrealised, have filled men's minds with saving yearning and a divine discontent. This yearning finds expression in works so far removed from one another as H. G. Wells' *Anticipations* and St. John's Apocalypse.

Our man of science will further tell you that while carefully bearing in mind the fact that the study of the sciences can never give us any generalisation that is more than probable, yet for practical purposes he divides a creed—your creed or his—into three compartments corresponding to the terms, Knowledge, Belief, and Over-Belief.[1] Under Knowledge, he will

[1] Perhaps more expressively rendered in the German equivalents—*Wissen*, *Glaube*, and *Aberglaube*.

include for himself all natural knowledge. Thus he will begin his creed: "I believe that one and one are two," and continue through all the sphere of knowledge until he has brought in the latest scientific discovery. Of course such bare recital does not necessarily include all that he will claim to know. He may feel assured, *e.g.*, that the creative activity has delight and complacency in maintaining the succession of the seasons, flowers, and human beings, and that too without any incompatibility in the death of the individual or even the extermination of the species. He might maintain that to him it is intuitionally revealed that Being is a good, that in any form it is worth having, that not merely man but beasts and flowers, mayhap the crystal, have a certain awareness of it and satisfaction in mere existence.

> "For love we Earth, then serve we all;
>   Her mystic secret then is ours:
> We fall, or view our treasures fall,
>   Unclouded, as beholds her flowers
>
> Earth, from a night of frosty wreck,
>   Enrobed in morning's mounted fire,
> When lowly, with a broken neck,
>   The crocus lays her cheek to mire."[1]

He might suppose the very elements on cross-examination saying: "It is worth while existing, and we are content to be here doing the will of God." Which if it were all true would mean that there is a very real sense in which there is no waste; "nothing walks with aimless feet." He might think of the myriad pollen grains that have failed to wake an egg-cell into fulness of life, yet out of their very *joie de vivre* reflecting, "No, we are not wasted, none of us, and we are all quite happy." And if all created

[1] G. Meredith, "The Thrush in February."

things have this *joie de vivre*, this *joie d'être*, then *a fortiori*, he infers, it is so with God. But such reflections would not fall within his category of experiential knowledge.

Under Belief, the man of Science might include, *e.g.*, personal immortality. He might believe in the immortality of his father, of his mother, of himself, for various reasons, although he does not know it to be a fact, and does not know anyone who does; he maintains that it cannot be a matter of Knowledge (*pace* the Psychical Research Society), nevertheless it cannot be disproved, which will differentiate it from all Over-belief. Having entered this region of belief he might even add a corollary, as *e.g.*, The immortal spirits of those whom we love, are and will be willing to help us. Christ, my father, my mother, each according to their ability in this unseen world, wishes me well, and will do me all the good they can; and in the degree in which each of them is co-extensive with God will be their power to help me.

Under Over-belief he will say that a person may cherish any belief that he thinks necessary or helpful to him in maintaining his Belief. One remarkable form of Over-belief is the doctrine of Transubstantiation, namely, that under certain conditions, and in a certain place, a wafer of bread is changed into the body of Christ. Here the true man of science will not scoff, but perhaps will say, "Go on believing for the present, if that is necessary to your Belief, and God be with you: I will try and find for you something more true upon which you can repose your faith."

Again, he will hold that it is Over-belief in the case of many people which leads them still to maintain that Moses, David, and Isaiah wrote all of certain

works associated with their names. Some are perfectly aware that they are hardly warranted in so believing: it is an over-belief on their part. Here the true man of science will not chide, but he will say, "Go on believing, if that is necessary to your Belief, but at any rate do not think hardly of those who do not share your belief. If your belief is sincere, not something held for social or ulterior selfish reason, we shall together be led into all truth."

Hitherto we have been discussing the scientific temper in religion, but there is the complementary side, which if not so obvious is at least as imperative—the religious temper in science. In proportion as the two tempers grow, there will come that final recognition of the relation of scientific and religious thought as twin expressions of fundamental truth. The revelation of order rather than of power as of the very essence of the world-process, the recognition of something akin to reason rather than to caprice as operative at the core of things, the realisation of human participation, direct and determinative, in this terrestrial mill, must profoundly influence not merely man's highest thought and deepest feeling, but every endeavour that is made to increase the sum of human knowledge. Under this conception of the religious temper in science would be included that sense of wonder—nay, even of reverence—that is strong in the heart of every scientific man whose eyes are really open. As he attempts to probe the secret of the constitution of matter, as he endeavours to comprehend the vital processes that are in evidence in the intra-cellular microsomes—units of life smaller than the microscopic cell,—as he reflects upon the evolutionary outlook with its vast perspective of progressive achievement, he is filled with a sense of wonder which surely is not far

removed from worship "in spirit and in truth." "He that wonders shall reign, and he that reigns shall rest."[1] Nor shall his rest be disturbed by any apparently humiliating discovery even in the natural history of Man; for he will have realised that the whole process is of God.

[1] An extra-canonical Logion or Saying of Jesus, first known as quoted by Clement of Alexandria from The Gospel according to the Hebrews: now recovered in its original form, cf. *The Oxyrhynchus Papyri*, Part iv. p. 4.

CHAPTER III

PRINCIPLES OF BIOLOGY

BIOLOGY is the science of life in the widest acceptation of that term. It deals with the general conclusions relating to life that may be drawn from study of the structure and activities of all living things. As such it is as intimately connected with the activities of the human organism as with those of the malarial parasite that passes a stage of its existence in his blood: it concerns itself with every feature in the apparently passive manifestation of the oak-tree's vitality, as in that of the active gall-fly, whose developing eggs stimulate the gall-formations upon its leaves. In popular thought, life displays itself in two great, apparently unrelated, fashions, corresponding to the animal and vegetable kingdom respectively—types which are undoubtedly sufficiently distinctive and apart in their most highly developed representatives, but which, as they are studied in a descending series, are found to become ever more simple, until forms are reached which, from the point of view of morphology, are practically alike in the two instances, although still differentiable physiologically: while eventually, certain forms are reached when the last differentia ceases to hold, and no unequivocal judgment can be passed upon their animal or vegetable nature. Yet let it not be imagined that to study life in these simpler

forms does anything more than eliminate certain secondary constituent elements. "Livingness" in itself is not more intelligible in the amœba than in the elephant.

The initial question of Biology is the nature and characteristics of living matter—the determination of that wherein "livingness" consists. Conceivably, this may be best attempted by considerations of the simpler forms of life: yet to solve the problem of their "least common measure" does not necessarily mean that we have determined the unit of life. Wherein, then, does "livingness" consist? Possibly we should instinctively reply, movement—movement, either purely locomotive, or such as is involved in the maintenance of the functions of nutrition and reproduction. Yet in the case of any seed or egg, life is somehow there, though we see no movement. We can ask about either the seed or the egg, Is it alive? or Is it capable of living? but these are obviously two very different questions. It is known that if dry seeds be kept for a long period in hermetically sealed jars they cease to respire, failing to manifest any chemical production of CO_2, one of the great signs of life. Hence their chemical answer to the question, Are you alive? is No. But does this answer necessarily imply that they are dead? And again the anwer is No, for if released from their prison and placed in suitable conditions they will germinate and produce new plants. "So that a seed, in so far as it does not manifest chemical change, is not proved to be living: and, inasmuch as it germinates, is proved not to be dead."[1] Of course, the usual escape from this dilemma is to say that the seed is in a state of latent life, during which, we may suppose, there is a complete suspension of all the chemical changes that are characteristic of the

[1] A. D. Waller, *The Signs of Life*, p. 5.

living state. But a more correct statement is that we have no means of chemical investigation sufficiently refined to reveal to us the infinitesimal changes that are probably going on in the apparently dormant seed: and it is further possible that chemical change may be almost completely suspended for a time (*e.g.* by low temperature) without that arrest being necessarily final. The reason for believing that infinitesimal changes, which our methods are too crude to detect, are going on in the seeds, simply is the experience in the first place that seeds that are kept for a long time do wear out, and that the percentage of seeds that germinate and grow gets smaller and smaller the longer they are kept. "The deterioration is more or less rapid according to the nature of the seed and the character of its protective coats, but in every known instance there is deterioration sooner or later,"[1]—deterioration, *i.e.* change, chemical change. We do not know, but it is not unreasonable to suppose, that the change is of the nature of a tendency towards stability on the part of the seed molecules as the result of the lack of specific stimulation. A stage is reached when the ability to respond finally vanishes. Similarly, in the contrary direction, the process of growth when once begun cannot be arrested: it must proceed, or the organism will disintegrate immediately. Life is a process rather than a condition. When once, as in the case of the developing egg, a certain temperature has disturbed its statically arranged molecules, proper energy must be furnished for continuing the process, or the whole structure dissociates and falls apart, and we say that the thing is dead.

Hence, with Waller, we ought probably to specify the character of the typical seed or egg in this way:

[1] Waller, *op. cit.* p. 6.

Matter—Not living—Formerly living—Capable of living again. They are physico-chemical structures whose life may begin, rather than living things themselves. Further, it has been shown that the vitality of seeds can be tested by the electromotive method (electrical changes being taken as the token of chemical changes, which are in turn a sign of life); so that in addition to the question, Are you alive? we can put the question to the seed, How much are you alive? and learn its answer in terms of electric units. Plants are obviously not as alive as animals, and in the case of the seed, different degrees of vitality will be shown corresponding with its age. At the same time we have made little advance in our inquiry as to wherein "livingness" consists. For the simple truth is that we cannot tell what life is. Yet if we cannot tell what life is, we can state what living things do. It is possible to make a series of statements descriptive, if not definitive, of living things.

1. All living things consist of a colloidal substance called Protoplasm. As seen in the simplest plants and animals, it is viscid and translucent, generally colourless, immiscible in water, and yet composed of it sometimes to the extent of 90 per cent. Chemically analysed, after treatment by re-agents, which rob it of its essential character, it is found to consist of various organic and inorganic compounds composed of carbon, hydrogen, oxygen, nitrogen, and sulphur, together with traces of various salts and other substances.[1] Phenomena like the precipitin reaction suggest a certain specificity in the protoplasm of different groups, yet in its simplest and most generalised form, this

[1] Reinke found that in the case of *Fuligo varians* (Flowers of Tan) the ash of the burnt protoplasm contains the following elements: chlorine, sulphur, phosphorus, potassium, sodium, magnesium, calcium, and iron.

complex of proteins,[1] carbohydrates,[2] fats, and acids, exhibits such a variety of qualities that the mere chemical synthesis of protoplasm is no longer a useful conception. The distinctive materialistic fallacy lies in the supposition that because the organic is chemically decomposable into the inorganic and has the same atomic composition, therefore the latter can give rise to the former.

Chief amongst these characteristic qualities is the fact of its organisation. Structureless protoplasm does not exist; the disclosed homogeneity is only apparent. Careful examination of protoplasm, even in that specialised condition in which it constitutes the cell-nucleus, shows that under the morphological aspect two main constituents are present, one of which, the more liquid ground substance, is continuously distributed throughout the meshes of a more active and, at the same time, firmer reticulum, as the second constituent is called. But it is just here that a certain divergence of opinion occurs, although it is always possible that of the two views most in favour, each expresses a part of the truth. Bütschli, together with a considerable number of biologists, looks upon protoplasm as essentially liquid, or rather a mixture of liquid colloids showing an emulcent structure in which the firmer portion forms the wall of separate chambers that are filled with minute, closely crowded drops of the more fluid portion. Any reticular appearance, therefore, is an illusion, being simply the sectional aspect of the alveolar structure.[3] The filmy walls

[1] $O_{72}H_{112}N_{18}O_{22}S$ = possible minimal composition of a molecule of egg albumen. The diameter is possibly 6 $\mu\mu$.

[2] *i.e.* starches, sugars, etc.

[3] With singular skill Bütschli succeeded in preparing artificial emulsions which show a striking resemblance to actual protoplasm in structure and in movement. More recently, and even more arrestingly, Léduc (*The*

may even in part be induced as the result of precipitation and other mutual chemical influences of the different colloidal elements. The majority of the earlier observers, together with a large modern school, hold to the view that asserts the presence of extremely delicate, though coherent, threads[1] which extend through the more liquid ground substance, either forming an uneven but continuous meshwork like the fibres of a sponge, or consisting of disconnected threads and their branches. Now, although it is undoubtedly true that in many instances protoplasm does present a vacuolar or foam-like structure, to admit this does not necessarily commit us to Bütschli's special theory of its intimate structure. On the other hand, the fibrillar network so often and so widely demonstrated, especially during cell-division, seems to be a general, perhaps the more typical and primitive, structure. Further, the clearer outer layer of protoplasm in a cell (ectoplasm) differs in many other characters from the darker and more granular inner portion (endoplasm). Hence we come with Oscar Hertwig to the conclusion that "the protoplasm of different organisms varies in its material, composition and structure. Apparently, however, these important differences are due to variations in molecular arrangement."[2] There is no universal mode in its structure; protoplasm is polymorphic, but it is just possible that the different types represent different phases of its development.

In virtue of this organisation the attempt is con-

Mechanism of Life) has produced osmotic creations that temporarily show features analogous to characters of living forms. His general conclusions, however, seem to be in advance of his data.

[1] Seen in living cells of cartilage, epithelium, connective tissue, and some other animal cells.

[2] *The Cell*, Eng. trans., p. 26.

tinually made to offer a complete explanation of the living thing in terms of mechanics. The living organism is certainly more of a mechanism than of a chemical compound, and its activities will find a better explanation along mechanical lines than in the mere consideration of its chemical nature. Doubtless the properties of the living cell may in the end be traced to chemical forces, just as in the case of the activities of the steam engine; yet no one will maintain that chemical forces explain the motion of the steam engine. The actions of the living cell will be better explained in terms of its mechanism than of its chemistry, yet even here imperfectly. Superficial resemblances that disclose themselves, in their greater or less completeness, simply serve to hide the critical points of difference. Thus it is obvious that in either case suitable fuel or food requires to be more or less continuously supplied—and all fuels are organic substances—that this food or fuel is subjected to definite changes in the interior of the mechanism, in the course of which heat is evolved, and that waste products are formed. Yet the living organism is unlike a mechanism in various respects.

(*a*) The organism is itself continually being changed in the course of its automatic developmental activity. The engine may be said to consume the fuel supplied to it, but it does not incorporate it in its own substance. The food, self-procured, of an organism is in a sense its fuel, but it becomes directly transformed into the machinery that is at work.

(*b*) The organism has a power of self-adjustment and regulation amounting to self-preservation which has not been added to it from the outside, and is not a necessary property of the substance of which it is composed: the activity of a machine, on the other

hand, is of no use to it in the line of preserving its integrity. In this feature of adaptability we seem to get close to the heart of life: in short, the changes can only be understood when regarded from the point of view of an inherent capacity to maintain the normal condition. In the course of certain experiments conducted with the object of determining the effects of low atmospheric pressure at the top of Pike's Peak, Colorado, Dr. J. S. Haldane was able to confirm the idea that mountain sickness was due to lack of oxygen, and further found that the body in the course of a few days tended to return to the normal. The nausea and other associated features of the condition disappeared, for "the lungs had begun to secrete oxygen actively into the blood and raised its saturation with oxygen. At the same time the lung ventilation was increased and the partial pressure of oxygen in the alveoli was raised correspondingly; and, thirdly, the oxygen-carrying power of the blood was raised by an increase in the number of the red blood corpuscles. By these means the oxygen supply to the tissues was restored to about the normal."[1] Yet while such adaptability explains the close correspondence between the side-tracked forms of life and their environment, it is helpless in itself to enable us to understand the character or general direction of the main-line movement.

(*c*) The organism has a certain regenerative power. In its case that which is consumed during activity is the actual machinery, and within definite limits food both fills up the gaps left in the mechanism and repairs any damage it may have sustained, whether self-inflicted or otherwise. The coal supplied to an engine does nothing to repair its tear and wear, nor can the engine execute its own repairs. It is here in particular

[1] *Brit. Med. Journal*, No. 2654, p. 1300.

that the mechanical hypothesis is reduced to its logical absurdity. Experimental data go to show that portions of certain organisms (Hydra, Clavelina) separated at any point in the early stages of development have the power of developing into the whole, if indeed on a reduced scale. Interpreted on the mechanical hypothesis, this would mean that in any selected portion of the whole which is, *ex hypothesi* a mechanism, there is ensconced a mechanism that will reproduce the whole, and the proven equi-potentiality of these portions means a multitude of such mechanisms localised precisely as the experimenter chooses to divide up the organism. The same conclusion follows from the fact that individual cells of the Echinus egg shaken apart at the 16-cell stage develop into miniature complete embryos, one-sixteenth the normal size. Again, the simple fact that in certain cases of regeneration, various tissues working to a great extent independently, combine harmoniously in a proportionate whole, which is, further, the same, although experimentally attainable by different developmental routes, so to speak, is more than sufficient to refute a purely mechanical interpretation of ontogeny.[1]

(*d*) A machine is constructed to execute a certain limited number of functions, and these it perpetually performs in the same way: the organism's range of activity is as wide and varied as its methods of operation. In particular no explanation could be afforded along such lines of the phenomena of autolysis,[2] whereby some of the chemical reactions associated with life are still observable in cells subjected to treatment which must go far to destroy their structure.

[1] Cf. Hans Driesch, *The Science and Philosophy of the Organism*, vol. i. pp. 158–161.

[2] Cf. F. Czapek, *Chemical Phenomena in Life*, pp. 14, 15.

(*e*) The organism can completely reproduce itself by means of parts thrown off from itself: there is nothing analogous to sexual reproduction in the inorganic kingdom. The simple fact that in reproduction the individual has a definite origin in time and space, seems to dispose of any fundamentally mechanical interpretation of inheritance. Between the idea of the fertilised egg-cell and its myriad divisions resulting in a whole wherein again are segregated cells that have the power to repeat the process, and anything that we can fairly associate with the word machine, there is no correspondence. We cannot imagine a machine that can subdivide continuously, retaining its wholeness, and yet can duplicate itself in certain of the products of self-division. To have such an entity in the living organism, and then apply to it the term machine, is simply to play with words.

(*f*) The activity of a machine is usually the sum of the activities of its constituent parts, but in the case of the organism it is something more, for its living unity is not merely represented by the sum of its organs, but involves a certain subtle interplay and mutual influence of its constituent activities. To express the total activity of an organism by the sum of all its separately analysed activities would be to omit all recognition of the relation—the rebounds, so to speak—which unite and pass between the several activities. There may be a mechanism of isolated parts, but in many cases they are detachable from the whole without vital damage; whence it would seem that the mechanism of the whole must be different, and at any rate indivisible. But this particular mechanism, in itself constantly changing and yet extending itself through time, is incommensurate with anything to which that term is usually applied.

In short, the differences are so great that unless they are steadily held in view the analogy becomes positively misleading. To attempt to explain the living organism and its activities in physico-chemical terminology is permissible as a scientific ideal. Even in that most difficult of all realms, the study of nervous process, Professor Gotch is perfectly entitled to claim that nervous activity "does not owe its physiological mystery to a new form of energy, but to the circumstance that a mode of energy displayed in the non-living world occurs in colloidal electrolytic substances of great chemical complexity."[1] On the other hand, to pretend that even an approximation has already been reached in general or in detail is mere myopia.

To all the above it may be objected that nevertheless the living organism is a mechanism and can be sufficiently explained along these lines. But this seems to beg the question. We can set forth all the distinctive qualities of living things and then state that they are mechanisms, but to do so is to rob the latter word of its ordinary significance, a significance that is in a parlous condition, seeing that the very principles of mechanics themselves are far from being satisfactorily determined. And in any case between that which exhibits spontaneous evidence of mind, and that which does not, there is an enormous difference which cannot be resolved by the mere application of the word mechanism to both.

The above discussion may then be considered as having indicated the relation of life to matter. The mere fact that the first touch of the chemical re-agent in the analysis of protoplasm robs it of its distinctive character, shows that life is not material: we know life only in association with matter, yet it is not matter.

[1] *Brit. Ass. Report*, 1906, p. 716.

A cat weighs no more or no less after the loss of its proverbial nine lives than it did in life. If life were material, then *ex hypothesi* it ought to weigh more in life than in death. On the contrary, an equally false impression that dead things weigh more, instead of less, than living things, is preserved in the popular expression, "a dead weight." Life, then, is not matter, nor is it exhausted by the concept of matter. In itself it occupies no space: it has no weight as we know gravity. It may be figured as the flow of something—a procession. Life is essentially labile.

2. All living things exhibit a directive control over energy which leads to its further availability. They are able to transform energy in their own interests, for their self-maintenance.

These statements deal with the relation of life to energy—in some ways the most complicated of all the problems that fall to be considered in this connection. In comparing what we know of life with all other forms of energy, we realise in the first place that the origin of the latter is under command in a way that is not predicable of the origin of life. A man strikes a flint and steel together, and so produces light and heat as often as he cares to repeat the operation: but he has no ability to treat non-living substances in such a way as to get life out of them. He can tap all the other forms of energy at any point: he cannot do so with life. Numerous experiments prove the transformation of energy and the ease of this transformation: but as yet there has been no hint of the direct transformation of any known form of energy into life, or *vice versa*.

Nevertheless, living matter is able to effect such transformations: it is, in fact, the seat of continuous transformation of energy. In these transformations there is nothing that goes contrary to the fundamental

laws of the conservation of matter and of energy: the potential energy in any food can be calculated, and the value found unimpaired in some type of equivalent work done or heat evolved. But this does not mean that there is nothing distinctive in connection with these transformations. Certain physical and chemical characteristics abide with the organism in death as in life; but when the typical energy phenomena are no longer in evidence we say that the thing is dead. Life, then, has to do with energy, but is not itself energy—not even a specific kind of energy. Its characteristic is seen in the way in which that energy is directed and controlled. The difference between a living and a dead cat is that the former is able to direct its energy into paths which are impossible for the dead animal with its equal stock of energy: the sum of energy is in no way affected. The energy of the dead cat flows along paths which are determined by external agency, and very quickly a state of equilibrium is reached: the energy is dissipated by heat radiation and slow combustion of the tissues—we can tell exactly how. The energy of the living cat flows along paths which are only indirectly determined by outside conditions, and we can only within a wide range of probability predict what particular form the expenditure will take—how the cat will jump. Every living thing is a centre at which energy is being constantly transformed—a mechanical energy-transformer—a centre, further, at which the tendency to degradation of energy is resisted. But it is more. It also acts as a directive channel along which energy can flow to accomplish specific work: as long as the organism is alive it is continually disturbing the equilibrium which should otherwise arise between itself and the environment and within its own elements. Life is unceasing, directive,

and selective[1] control of energy: like some invisible charioteer it stands athwart a complex of moving forces, constraining and controlling them. But it is also accumulation of energy, *e.g.* in specific tissues and a transformation of it leading to further availability. The organism up to a certain stage appears to be continually gaining energy at the expense of the environment.

There are, however, other controls of energy: temperature, *e.g.*, controls its passage in the form of heat from the warmer to the colder body. But this passage involves not merely degradation in that particular form. Hibbert[2] brings out very clearly that the difference in temperature is a determining factor, and that in any calculation of work done it will find a place; whereas it is impossible to show that life is a factorial element in any calculation of the work done by a living organism. The nearest parallel, yet hardly a parallel, would be in the unique characteristic of reproduction, when, owing to the accumulation of energy, it may reasonably be conceived that the control or potential factor exhibits itself in the process of division. This control is superlatively seen in the development of the segmenting egg to its predestined goal in the typical adult form. Accordingly, we conclude that after the methods borrowed from the analysis of inorganic nature are exhausted, there is a residuum of fact which is untouched by them, viz. the directive control and co-ordinated adaptation of every element of its activity by the organism to its own end. The biological whole is greater than the sum of its physical or chemical parts. And it is no objection to urge that we are not objectively aware of this peculiar control (*i.e.* it is not located in any particular organisa-

[1] In the sense that it selects this or that mode of attaining an end.

[2] W. Hibbert, *Life and Energy*, p. 50.

tion), for the same is true of all physical actions, as *e.g.* gravitational attraction. Life is known to us as control and guidance of energy, interacting with matter in ways which if not yet wholly intelligible to us, are clearly not covered by what we know of its physico-chemical properties.

3. All living things are characterised by cellular structure. Life, that is to say, so far as we know it to-day, appears in one typical form—that of the cell. In the case of the higher forms of life, the size and shape of the cell are more constant than the size and shape of the individual. The farther apart living forms are from the point of view of classification, the deeper is it necessary to go to find community. In extreme cases this may be found only in their cell structure and protoplasm: hence the fundamental importance of these aspects. It is, then, a matter of observation that the bodies of every form of life, plant or animal, are commonly composed of one or more minute structural units known as cells, into which, in the case of higher forms, directly or indirectly, every part has been secondarily subdivided: all organisms consist of cells and of cell products. The body is a mosaic rather than an asphalt, but the cells are in communication, unisolated by cement. Traces of the primitive asphalt are however sometimes preserved, as in the vertebrate retina.[1] From the view-point of this cell-theory, the animal kingdom (as likewise the plant kingdom) may be regarded as an ascending series at the bottom of which will be put those forms that are unicellular — the Protozoa. Next above them, although essentially of them, come forms that are mere balls or colonies of cells, e.g. *Volvox globator.*

[1] Cf. H. M. Bernard, *Some Neglected Factors in Evolution*, p. 222 *et seq.*

Thereafter we reach the sponges, where tissues, *i.e.* aggregates of similar cells performing a single function in common, are, as it were, in the making. Next come the simpler members of the Cœlenterata—mere two-layered sacs of cells, with hints of organs, *i.e.* higher complexes of tissues devoted to one or more specific functions, and so we arrive at those higher

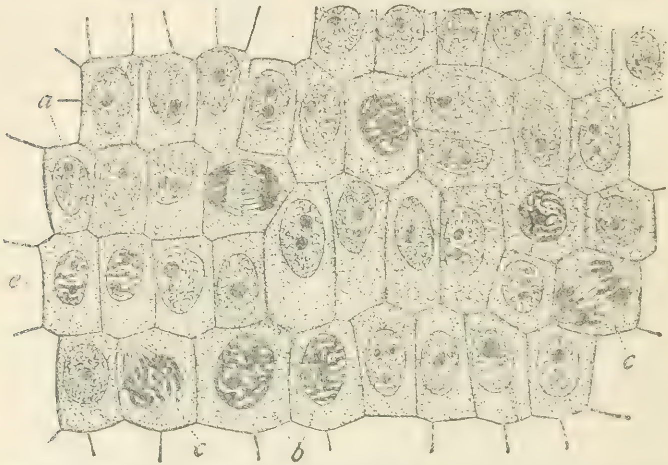


FIG. I.—GENERAL VIEW OF CELLS IN THE GROWING ROOT-TIP OF THE ONION, FROM A LONGITUDINAL SECTION (× 800).—(*a*) Non-dividing cells with chromatin-network and deeply stained nucleoli; (*b*) nuclei preparing for division (chromatin in form of continuous thread); (*c*) dividing cells showing mitotic figures; (*e*) pair of daughter-cells shortly after division. (From Wilson's *The Cell*, by kind permission.)

forms, the substance of whose skin, bone, or muscle is not homogeneous according to the naked-eye impression, but with the help of the microscope is usually resolved into aggregates of those countless minute units called cells. And it may be here remarked that Ontogeny discloses the remarkable fact that every one of these higher forms, in its individual life-history, passes

through a broadly corresponding series, of which the first stage is likewise a single cell, the fertilised ovum. Palæontology, as interpreted by Evolution, teaches the further striking fact that what is thus true of the individual history holds likewise of the history of the race, which began in the farthest æons with the simplest forms and progressed till it culminated, mentally and spiritually, in man.

But in addition to thus furnishing us with a valuable point of view from which to regard the organic world in relation to structure (Morphology), the cell-theory performs a similar service from the point of view of function or activity (Physiology). The cell is not merely a unit of organisation: it is a unit of function. In every protozoon the vital functions—locomotion, respiration (or whatever corresponds to it), absorption of food, digestion, excretion, which in the higher forms are distributed amongst different cells or organs devoted to the discharge of these specific functions—are all performed by the single cell. On the other hand it must be as strenuously maintained that the cell is not an absolute unit, and is as decomposable into lesser units as it is aggregable into individuals of a higher order.

Even in the minute study of the cell, however, the enigma of life is not more simply presented for solution: indeed, the solution seems farther off the deeper we pry. In addition to the protoplasm that constitutes the cell body proper (cytoplasm), investigation discloses the presence of the nucleus, which, with few exceptions, is a characteristic of every cell. Modern theories of heredity are in great part theories of the cell-nucleus.

The nucleus was first discovered in 1833 by Robert Brown in plant cells; but the signal rôle that it plays

in the economy of the cell was not grasped till long afterwards. Thus phenomena of protozoan regeneration show it to be a formative centre; as such it is almost necessarily the chief chemical centre in the cell. Indeed, we are compelled to think of a ceaseless interchange, a sort of whirlpool effect, as continually

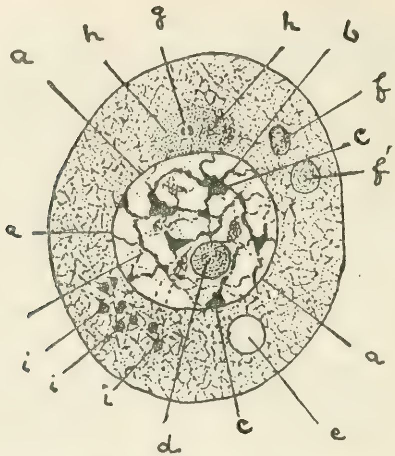


FIG. 2.—SEMI-DIAGRAMMATIC REPRESENTATION OF A CELL. — (*a*) Nuclear membrane; (*b*) linin reticulum; (*c*) chromatin masses contained in envelopes of linin (chromatin nucleoli); (*d*) true nucleolus; (*e*) vacuole; (*f*) plastids; (*g*) centrosomes; (*h*) archoplasm, from which attraction-sphere, astral rays, etc., are developed; (*i*) food particles. (From Walker's *Essentials of Cytology*, by kind permission of the publishers.)

going on between nucleus and cytoplasm. Typically spherical, it may assume a variety of shapes: typically single, it may be double as in some liver cells, triple or quadruple as in some Ciliata, or even multiplied a hundredfold as sometimes in the giant cells of bone marrow. It also occurs in all degrees of organisation.

In any ordinary nucleus, the following structural elements may commonly be recognised:—

(α) The nuclear membrane, which is probably a concentration or felting of the original reticulum, thus permitting of direct communication between, if not direct continuity of, the intra- and extra-nuclear filaments.

(β) The nuclear reticulum, which is composed of two distinct substances—chromatin and linin. The former is ordinarily confined to the nucleus, where it is generally seen as irregular, deeply staining granules and masses, deposited, as it were, on the threads of linin, sometimes irregularly, at other times with such regularity that the meshwork seems entirely composed of them. Indeed, the relation is often of a more intimate character, so that the chromatin seems embedded in the linin. Some of the most recent work suggests that the chromatin, on which hitherto such stress has been laid in connection with theories of inheritance, is nothing more than a secretion of the linin, and that it is really with the latter that any ideas of permanence and individuality should be associated. The most striking support for this view is found in the way in which during certain critical phases of the nuclear history the chromatin decreases in amount, sometimes even to the vanishing point, and may be supposed to have been employed in nourishing the cell during the stage in question.[1] But this is an over-statement. Chromatin is certainly used up in all functional activity and is the more chemically active of the two elements, but it is indispensable to life, and the granules even move along the linin filaments towards the locality of need.

[1] Unless, however, we assume that the response of chromatin to stain is constant, it may be that this capacity for stain varies with circumstances. Such a variability seems to be characteristic of the protozoan nucleus.

Bernard has demonstrated the migration of chromatin outward towards the peripheral nerve endings in the retina, in connection with processes involving not merely the expenditure of the chromatin but also its creation. The linin likewise after treatment shows a granular structure, and seems similar in composition to the cytoplasmic reticulum. The quantity of chromatin in a nucleus is not constant, for the granules are capable of assimilation, growth, and division. In the processes connected with cell division and fertilisation they aggregate into little rod-like bodies known as chromosomes, and the longitudinal division of a chromosome involves the actual splitting of its component granules. The number of chromosomes is constant for each species,[1] and they are now regarded by many as vehicles of inheritance. That they alone function in this way may be doubted. So close is the intercourse between nucleus and cytoplasm that it is difficult to deny to the latter certain character-determining qualities. Indeed, it is probable that while racial characters are associated with the cytoplasm, individual characters are more immediately concerned with the chromosomes, being represented there, possibly by specific entities.

It is still a matter of considerable doubt whether the chromatin granules of the reticulum are individually identical with those that constitute the chromosomes. This quest of the biological ultimate becomes more complicated when we further inquire into the relation of chromatin granules to the linin network not merely of the nucleus but of the cytoplasm. For some recent research has tended to confirm van Beneden's conclusion, reached already in 1883, that the chromatin network of the nucleus, the cytoplasmic reticulum,

[1] *e.g.* man 32, mouse and lily 24, etc.

and even the nuclear membrane, are all alike built up out of granules united by connective substance, and that even the chromatin granules may be transformed into achromatic, and *vice versa*. The sole limitation appears to be the restriction of the chromatic granules ordinarily to the nucleus, while, on the other hand, the linin network of the nucleus appears to have the same granular structure as the cytoplasmic reticulum, and the nuclear membrane appears to originate in a condensation or felting of the same substance. Can we then associate these granules with the ultimate units of life? Yes and No. Yes, in the sense that such a chromatin granule associated with short filaments radiating from its core, supported and extended by a unit mass of nucleoplasm,[1] affords us a theoretic unit capable of growth and division in its particular environment—incapable, however, of an extravital existence. No, in the double sense that on the one hand we can hardly suppose that the ultimate units of living matter happen to coincide with the revelations of the most powerful microscope of the twentieth century; and that on the other hand if we insist on independent existence in a purely physical environment such a suggested unit fails to respond to the criterion. We must obviously, therefore, look to our terminology. Possibly, in a more restricted sense some of these elements of protoplasm might be spoken of as "living." Under certain conditions the line between the living and the dead cannot be sharply drawn. "In its fullest meaning, however," says Wilson,[2] "the word 'living' implies the existence of a group of co-operating activities more complex than those manifested by any one substance or structural element.

[1] Bernard, *op. cit.* p. 10.

[2] E. B. Wilson, *The Cell in Development and Inheritance*, p. 29.

Life, perhaps, should only properly be regarded as a property of the cell-system as a whole, and we do better to designate the separate elements as 'active' and 'passive' rather than as 'living' or 'lifeless.'" The enucleated cell cannot reproduce: in the absence

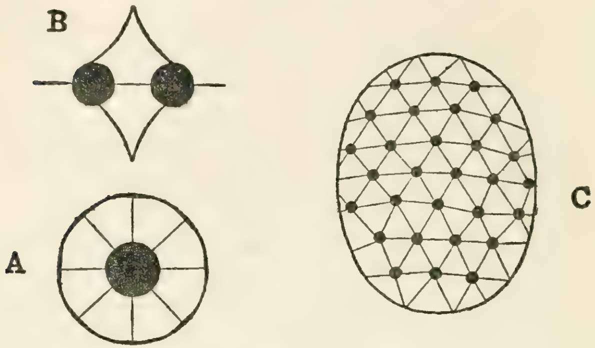


FIG. 3.

A. The chromidial unit as a mass of chromatin with linin threads, which are at the same time nervous, contractile, and synthetic. The waste matters of its chemical reactions, carried out from the central mass along the linin threads, are deposited as a pellicle at the surface of the fluid mass in which the whole is embedded. The tips of the linin filaments project slightly beyond the pellicle as nerves.

B. Diagram illustrating the division of the unit; the linin threads in or near the plane of division split longitudinally, while those in or near the plane joining the centres of the daughter units simply lengthen out.

C. An optical section of the three-dimensional network which would result from repeated incomplete divisions of such a chromidial unit; the chromatin masses divide completely, but the linin threads, though they lengthen and split, are never ruptured.

(From H. M. Bernard's *Some Neglected Factors in Evolution.*)

of nuclear material all synthetic metabolism is at an end. Strictly, therefore, such a cell is not living, although for a short time any small portion of it even may still show characteristics of life, *e.g.* irritability, and other destructive aspects of metabolism. On the other hand, the fragments of a unicellular organism

that contain the nucleus or a part of the nucleus can re-acquire the specific form in time. Although the cell is ordinarily taken as the unit of life it becomes increasingly difficult to maintain any thoroughgoing cell doctrine. The reproduction of amœba through fragmentation and conjugation of the units raises the problem of the One and the Many in a bewildering fashion, and puts limits to the description of that and other types as unicellular forms. Not merely the study of the intimate structure of protoplasm but also of the types of Protozoa with a so-called distributed nucleus, in some cases of which an actual clustering is noticeable at a certain stage, and many other data[1] suggest such a precellular unit termed by Bernard the chromidial unit, by the continued division of which with the later concentration and differentiation of the various massed elements, the typical cell is ultimately formed. This points to the cell as being "primarily a continuous linin-chromatic network with a differentiated centre which is a storehouse for chromatin, the whole being embedded in an albuminous semi-fluid matrix."[2] The concentration of chromatin in the matted tangle of the nucleus with the corresponding felting of the filaments must have led to greater efficiency and co-ordination in response to the environmental stimuli, increased facility in the despatch and localisation of chromatin at points where expenditure of energy was demanded, and the opening up of possibilities of differentiation in the filaments as nervous and muscular elements such as could not be obtained in a simple continuum of chromidial units. The chromatin is associated with the energy transformations and may be thought of as the seat of chemical activity: the

[1] Cf. *e.g.* H. M. Bernard, *Studies in Retina*, Q.J.M.S., vols. 43–47.

[2] Bernard, *op. cit.* p. 32.

linin filaments are primitively contractile, nervous and synthetic in function, and would regionally become increasingly differentiated along these lines. Thus cilia find a sufficient explanation as terminal extensions of the originally uniformly distributed linin-chromatin network, while even the organisation of by-products like protozoan shells suggests by their radial structure an intimate connection with the linin filaments in their synthetic activity.

The demonstration of intracellular units of a lower order has an interesting bearing upon biological theory. Altmann's granular theory of the constitution of protoplasm, ill-founded as it apparently was in relation to his own investigations, regarded protoplasm as a colony of more elementary, extremely minute units which he called bioblasts. In a real measure these chromidia, evidencing assimilation, growth, and division,[1] correspond to Altmann's theoretical units with this immense advantage that in the linin filaments they have a means of communication with one another. They invite consideration as more elementary individuals than the cell, standing between the latter and the ultimate molecule of living matter. Herbert Spencer's "physiological units," Darwin's "gemmules," and Weismann's "biophors," all hitherto hypothetical units, playing the principal part in the theories of regeneration, development, and heredity associated with these great names, would thus appear to correspond to a reality.

(γ) The nucleoli, rounded irregular bodies composed of a protein substance markedly different from chromatin. They are, however, very varied both in

[1] This is strictly true of the chromatin granules, and the chromidial unit as suggested by Bernard seems phylogenetically probable and may even yet be found represented amongst micrococci.

structure and character, and in some instances, at any rate, are possibly a source of chromatin supply for the nucleus. They stain deeply, giving reactions similar to those presented by the fibrillar network.

(δ) The nuclear sap or ground substance occupying the interstices of the network, and apparently unaffected by many of the stains that act on the chromatin. It is clear, highly refractive, and essentially liquid. Its functions in relation to the maintenance of turgescence and as a support to the linin-chromatin network, quite apart from all questions of chemical interchange, are highly important.

A third element of the cell is the peculiar little centrosome first definitely discovered by van Beneden in 1885, which as the special organ of cell division is often regarded as the dynamic centre of the cell. It commonly lies outside the nucleus, although close to it, sometimes, however, inside (*Ascaris univalens*). It may be surrounded either by a radiating area of the cytoreticulum, termed the attraction sphere or centrosphere; or by an area of protoplasm denser than the rest of the cytoplasm (archoplasm). Sometimes in the vegetative stage it lies unattended by any differentiated matter, and is then often very difficult to demonstrate. Typically the centrosome, which stains deeply and resembles a chromatin granule, is a single organ; but as a rule dividing cells show a double centrosome due to anticipation of the succeeding division in which each of the daughter cells receives one of them. The failure to substantiate its presence in the case of the cells of many of the higher plants, and the fact that in some instances at the close of cell division, or during fertilisation in animals, it disappears entirely to appear again *de novo*, rather militate against the earlier view of its indispensable and

dominant function as an organ, although as a *locus* of specific chemical stimulation something undoubtedly exists. At the same time in the majority of cases as an organ that assimilates, grows, divides, and is in many cases passed on from cell to cell, it also answers to the conception of an intracellular unit of independent existence. It is essentially a centre of determining activity, and it seems to finally disappear with the loss of the power of reproduction.

With regard to the cell wall or membrane, we now know, unlike the earliest observers, that its importance is secondary. It is more characteristic of plant than of animal tissues. In the former case it has a more or less firm consistency, and is often of considerable thickness: on the other hand, many animal cells, *e.g.* rhizopods and leucocytes, are "naked," although even here some difference in consistency can be established between the outermost layer of the cytoplasm and that immediately beneath it. Where a definite membrane or skeletal structure occurs, it may arise either as a secretion product, probably in direct association with the linin filaments of the network along which the transformed substances pass, or as a direct physical and chemical transformation of the peripheral layer of protoplasm, also under the influence of the original chromatin-linin network.

Hitherto we have regarded the cell as an independent organism, as an organic unit. Actually, however, it is such only in the case of unicellular organisms and the germ-cells of multicellular forms. When we consider other cells, *e.g.* the tissue-cells of the higher creatures, we see that in point of origin and structure, *i.e.* morphologically, they are equivalent to a collection of unicellular organisms, but physiologically the tissue-cell can hardly be regarded as

independent, inasmuch as its activity is part and parcel of that of the organism—"its autonomy," to use Wilson's phrase, "is merged in a greater or less degree into the general life of the organism."[1]

Now, it is difficult to imagine a more engrossing problem than that of the co-ordination of the individual cell activities. What is this organic unity of the body, and how is it maintained? The older workers thought of the organism as a composite, a mosaic, whose life was simply the sum of the life of its independent, yet reciprocating parts. But it becomes increasingly clear that so far as growth and development are concerned, cells can only be regarded as co-operative units in a limited degree. "They are rather," says Wilson, "local centres of a formative power pervading the growing mass as a whole, and the physiological autonomy of the individual cell falls into the background."[2] No true conception of the life of a multicellular organism is gained except in so far as that life is conceived of as a whole, untrammelled by cell boundaries. Doubtless it expresses itself in many ways, particularly in the form of the cell, thereby giving to itself an apparently composite character. But in reality this mosaic-like character is due to the secondary distribution of the organism's energy among local centres of action. This distribution follows the lines of linin-filamentous connection between the cells of any multicellular organism. Delicate intercellular bridges of protoplasm are demonstrable in many cases between the individual cells of plant and animal tissue (*e.g.* the epidermis in particular), but when the relation of the cell to its precellular units is realised, the close connection of the units in a multicellular organism is seen to follow as the necessary result of divisions of a

[1] *Op. cit.* p. 58. [2] *Op. cit.* p. 59.

linin-chromatin network, the chromatin elements in which undoubtedly are grouped together as the daughter nuclei, while the linin elements are forced to remain in some degree in organic continuity.[1]

The problem is very much the problem of the cell and its enzymes repeated on a larger scale. There, as we shall see, the question is how the cell links together, and co-ordinates the activities of various substances within it, each of them with its specific industry, so to speak. In the higher animals and plants the different tissues retain in varying capacities vestiges of the primitive power of altering their function:[2] under normal conditions they behave according to their specific character. But evidently there is some restraining influence that limits and regulates the activity of any particular cell, or group of cells, in relation to the other cells of the organism.

4. A further characteristic of living things is irritability, by which is understood the capacity for response or reaction to stimulus. Life, in fact, resolves itself into the science of response,—response to various external and internal stimuli,—simple at first in the case of the lower forms, but infinitely complex in the higher forms, embracing in the last instance all that is implied in the word "education": the unresponsive is the dead, that peculiar condition in which the capacity for response is gone.

Now, in all applications of stimuli to living matter, what we see, as a direct consequence, is a series of very complex phenomena due to the fact that these

[1] Cf. H. M. Bernard, *op. cit.* pp. 85, 95.

[2] One modern explanation of cancerous growth regards it as an assertion of this primitive independence; the cells function in an unusual way under certain special conditions,—excessive multiplication, possibly due to superfluity of chromatin.

stimuli have affected an exceedingly complex object in the organism upon which they act. When these phenomena of irritability, as exemplified, say, in a protozoon, are analysed, we find a series of specific capacities for response which have been styled tactisms. *Paramecium* is sensitive to light in that it moves towards it; it is therefore positively phototactic. Irritability, then, usually expresses itself in some form of movement of the organic mass, which has often led to this feature being set down as a characteristic of living matter; but while every response need not necessarily be in the form of obvious movement,—the energy liberated may take some other form, *e.g.* heat, or light as in the case of the firefly,—on the other hand, in many cases of apparently spontaneous movement, the cause is to be found in internal changes rather than in the external environment. It is essentially a liberation of energy—the transformation of potential into kinetic energy, and this commonly shows itself in movement.

The expression of this irritability was almost certainly originally associated with the linin elements in the protoplasmic reticulum. For irritability is as marked in protozoon and sponge as in the higher forms of life, and the only structure through which a response could be given in default of anything comparable to a nervous system is the linin reticulum, which is contractile and capable of transferring stimuli —a primitive undifferentiated nervous tract. That this original network underwent differentiation in connection with other elementary functions[1] did not hinder certain portions and tracts developing as a nervous system in complexity proportionate to that of

[1] For the detailed proof of this statement, reference should be made to Bernard, *op. cit.*, chap. xi.

the organism as a whole. Such specialisation of tissue for other functions would necessarily involve the inhibition and decline of the original elementarily nervous character of the reticulum in these regions.

In the case of the higher animals and plants, the distinctive elements of irritability, studied singly as tactisms in the case of unicellular forms, may function in a specific way in the parts of a multicellular organism, giving rise to movements known as tropisms: thus a characteristic turning towards the sun gives its name to the flower heliotrope. It has been suggested that many movements of animals and attitudes of plants depend upon mechanisms that are "a function of the symmetrical structure and symmetrical distribution of irritability on the surface of the body of the organisms."[1] This involves the assumption that symmetrical points on the surface of an animal possess corresponding degrees of irritability. If, then, lines of force (*e.g.* light rays, gravitation lines, lines of diffusion) strike an organism with greater profusion on one side than on another, the tension of the contractile elements is unequal, and if the animal moves, it will tend to turn in such a direction that the lines of force impinge with equal density at symmetrical points, and at the same angle on both sides, and it will continue to move in that direction, or away from it, according as it is apparently attracted or repelled. Such automatic orientation in a field of force toward or away from the centre of force constitutes the so-called tropism. That is to say, it is not curiosity, or love of light, that makes the moth fly to the candle flame, but the compelling power of the light in turning the creature's head towards it. This line of interpretation, however, has been shown to be

[1] J. Loeb, *The Dynamics of Living Matter*, p. 5.

insufficient in the case of humbler forms,[1] and is probably not less so here.

The external stimuli which act upon the world of life are manifold, being thermal, luminous, chemical, etc., in character. The reaction of an organism is, then, simply its response to the particular stimulus applied to it. The experience of everyday life is sufficient to show us that under the same stimulus that reaction will vary considerably with different individuals. In fact, the same stimulus may produce totally different effects on differently constituted objects. A kick elicits a different response in the case of a stone, a bulldog, and a Skye terrier: under electrical stimulation the salivary gland yields its saliva, the liver its bile. On the other hand, it is not so obvious at first sight that very different stimuli will but produce identical effects upon the same protoplasmic body. Yet apply to a muscle cell electrical, chemical, in short, any possible form of stimulus: it has but one answer—it contracts. The same holds good for many Protozoa: they have but a single characteristic response to all kinds of stimuli. We have thought of the stimulus as exciting or even producing an increase of the specific activity in various forms of living substance: its action may, however, also result in a diminution of that characteristic activity. Irritability is considered to be a fundamental property of living protoplasm, but it expresses itself in specific actions, according to the specific structure of the organism, under the influence of the external world.

With this fundamental property of irritability, of which certain other properties of protoplasm are ultimately but different specific expressions, may be considered the characteristic of insusceptibility in varying

[1] Cf. p. 301.

degrees, or functional inertia—to use the term proposed by Harris.[1] By this is meant not merely the relationships of living matter to stimuli in which it shows no response, but also those states in which it continues to respond specifically after the stimulus has ceased to act, or an inhibitory stimulus has been applied. Life is not in tissue, organ, organism, or even society a continuous march, due to everlasting response to unceasing stimuli, such as it would be if irritability alone were characteristic of living things. We are aware of limits of stimulation, of calculable pauses till the effect of the stimulus is seen, of a not uncommon lack of correspondence between stimuli and responses, of certain protoplasmic activities apparently spontaneous and automatic in their persistence under conditions that united almost tend to suppress them. Thus, in a sense, at any moment the expression of an organism's life is the resultant of these antagonistic properties of irritability and functional inertia which are present in varying and characteristic degrees. The presence of this biological inertia lies rather in non-correspondence with the environment of impinging stimuli.

Of the various phenomena expressive of this inertia those that illustrate a "latent period" between the application of a stimulus and the appearance of the resulting response are the most general and the best adapted to demonstration. They are observable in the Protozoa, characteristic of muscle, nerve, and other tissue in higher forms, and are peculiarly striking in certain vegetable protoplasmic reactions. This "physiological lost time" permits of definite calculation, giving thus in some degree a measurement of the inertia. Again, lack of correspondence between constant stimuli and response appears in the form of rhythmic move-

[1] D. F. Harris, *The Functional Inertia of Living Matter.*

ments seen *e.g.* in connection with the respiratory centres, and this seems best explained in terms of protoplasmic inertia and susceptibility. In the case of a dry seed we may consider its inertia to be at a maximum for any given stimulus, although it may be overcome by a definite combination of them. In those cases where specific action persists after cessation of the stimulus, and even in local post-mortem growth, we have phenomena comparable to the continued swinging of a gate after a push, which point to a functional inertia in living matter. When we widen our range and consider individual and racial characteristics, we may see in heredity the broadest expression of this functional inertia, displaying itself in physical and psychical realms alike. Habit and instinct owe their existence to such inertia: in it are some mainsprings of character. How far this characteristic of living organisms is directly connected with any similar property of the ultimate molecules of living matter is a question upon which as yet we have not sufficient data to come to a certain conclusion. When confined to the physical aspects of protoplasm we have an explanation that is within the range of probability. But to state in particular as Harris does [1] that "mind has inertia because cerebral protoplasm has inertia, and cerebral protoplasm has inertia in common with the lowliest fraction of living matter" is to offer an explanation in terms of a causal relation between matter and mind that is not warranted by any facts at our command.

[1] *Op. cit.* p. 86.

CHAPTER IV

PRINCIPLES OF BIOLOGY (*continued*)

5. ALL living things are further characterised by continual change, physical and chemical, of the material composing the body in every part. Certain parts are being continually used up, and fresh material is brought in and built up into its place. This ceaseless internal cycle of supply and waste, waste and supply, is designated by the term, metabolism. The living organism is as a flame that, fed with oil, preserves its outward form, yet all the while the substance by which the flame is fed is being decomposed into its constituent elements and passes off transformed. Biology, apart from Morphology, knows no statics. Nutrition and digestion, respiration and circulation, secretion and excretion, are various phases of this comprehensive activity. In order to live, the cell must absorb nutrient substances which it proceeds to elaborate, retaining some portions within its body, and rejecting others. Continually in the living cell substances of complex molecular—and in that measure unstable—structure are being built up from substances less complex and more stable, with the absorption of energy: concurrently, other substances—food reserves, or the protoplasm itself—are being broken down in order to provide the energy required. The more intense the life, the more comprehensive are those parallel processes of construction and destruction.[1] And yet if parallel, they are hardly equal.

[1] Or, more technically, anabolism and katabolism.

In the period of youth the constructive is in excess of the destructive, and we say the organism grows.

Now, all living things grow in a sense that is not predicable of other objects to which the word may be applied. For in the saturated solution of salt or alum the crystal grows by accretion—particles are added on the outside, layer by layer: living things grow by taking up particles of matter in between already existing particles at every point—interstitial growth. Further, the crystal grows by adding to itself particles of the same matter as itself—particles that it takes up, already existing, out of the fluid around it; whereas the living thing makes the materials of its growth, manufacturing particles like itself out of material different from itself, which it then uses for growth—by assimilation. The ciliate protozoon, *Paramecium caud.*, if kept in a hay infusion at a definite temperature, will grow and reproduce by binary fission at a definite rate. This growth and reproduction are accomplished at the expense of elements in the medium which are transformed into *Paramecium*: at the same time other substances appear in the medium which are the waste from the growth process. If we call these last b, and let a represent the material that goes to form new *Paramecium*, then $P + a = nP + b$. This growth formula may be instructively compared with that of any purely chemical equation, with the result that a striking difference is noticeable. In the case of an effective chemical reaction between different compounds, the result will be found to be of the general character $A + B = C + D$, *i.e.* different substances are found in the two terms (*e.g.* $Zn + H_2SO_4 = ZnSO_4 + H_2$).[1] In the former equation

[1] This statement excludes the phenomena of catalysis, between which and some aspects of metabolism a certain measure of analogy may be traced. Cf. pp. 89, 90.

the fact that P appears on either side constitutes a veiled expression of a characteristic of life: that it occurs in a greatly increased quantity indicates the amount of growth. As a matter of fact, however, this formula represents but half of what is actually in progress; for at the same time other processes of a contrary or destructive character are in operation, and the organism is alive only so long as they do not gain the ascendency over the assimilative activities.

From the work of destruction, which may involve the breaking up of complex substances into simpler ones, or their combination with oxygen, various final products arise, some useful to the organism, *e.g.* bile, others not so useful, or positively harmful, as urea, carbon dioxide, and mineral salts. In the case of animals the whole of their energy is derived from waste; in plants only a small part is thus derived, the rest being obtained from sunlight. The metabolic processes that are going on in any higher organism, plant or animal, are manifold in the extreme, and even in the case of unicellular forms our understanding of them is far from complete. At the same time the unity of the entire organic kingdom is well illustrated in a restricted series of fundamental metabolic processes which are common to every living thing.

(*a*) Every plant and animal respires, *i.e.* it takes up oxygen from its environment, whereby it oxidises the carbo-hydrates and albuminous substances of its own body, producing as final products carbon dioxide and water. Oxidation in living matter is however a much more complicated process than the simple chemical activity ordinarily expressed by the term: there is much in it that is physical as well.

(*b*) The food materials of all living organisms, plant and animal alike, are originally prepared from the

inorganic world through the instrumentality of chloroplasts. Further, while it is true that growing plants are able to live on simpler compounds than animals, yet a study of the development of the embryo in the seed [1] shows it to be without the adult capacity, and dependent on manufactured carbo-hydrates, proteins, and fats, as in the case of animals. The differences relating to the mode of supply in the case of the two kingdoms are ultimately referable to differences in the cell structure. The exaggerated development of the vegetable cell-wall prevents the ingestion of solid material.

(*c*) In both animal and vegetable kingdoms, characteristic, and in some instances corresponding, substances make their appearance during metabolism, and play a very important regulative part, not merely in the constructive process but also in the breaking up of reserves and in excretion. These substances, *e.g.* diastase in plants and ptyalin in saliva,[2] are known as enzymes and are marked by very distinctive features. Thus in the course of their activities they undergo no change in themselves. They do work out of all proportion to their quantity, without leaving a trace of their own substance in the products of their activity. Such characters invite comparison with the catalytic substances of pure chemistry, but the differences are no less marked. So fundamental is the action of these enzymes that there is a very true, if limited sense, in which it may be said that life is the enzyme (first degree) of enzymes (second degree). The evidence goes to show that some kind of enzyme is at the basis of every functional activity. Digestion is due in part

[1] The same also holds true of growing cells in a young stem or root.

[2] The function of both of these is in general terms to change starch into sugar.

to the action of pepsin which breaks up proteins. Respiration is only achieved through the presence of oxidase, which seizes the oxygen in the lungs, and hands it over to the red corpuscles of the blood. Under certain conditions—commonly greater condensation of the solution—the action of some enzymes is reversible, *i.e.* they can put together again what they have taken apart, and there are others that devote themselves solely to this aspect of the matter. What the enzyme is in its inner nature or how it is produced is still unknown. Mostly soluble in water or some other medium, and colloidal in character, they prove but slightly resistant to heat. Possibly they are morphologically comparable to units of the chromidial or even pre-chromidial days, just as in the human body we find survivals of the unicellular period in the leucocytes of the blood. Investigation into their nature proceeds apace, and marvellous success has been achieved in some instances in separating and instigating them to work apart from the living environment (*e.g.* pepsin): others prove as yet to be inseparable from the living protoplasm.

It should, however, be remembered that no account of enzyme-action, however complete, does in the least help our ultimate account of life, since it gives us no clue to the characteristic achievement of the cell in connecting, co-ordinating, and regulating these various activities that take place within it. Not merely is the enzyme an organic production, of which there are sometimes several types at work in the economy of a single cell, but, unlike the ordinary catalyser, each enzyme is usually only able to act in its specific way upon one definite type of molecular arrangement, while the cell as an energy transformer is distinguished by the way in which it connects the varied complex

reactions effected by these enzymes which it has itself produced. Accordingly, to consider the cell activity as simply the sum of its varied enzyme activity, is to make the same mistake as to suppose that an organism is the sum of its organs. It is to offer only a partial account of cell life. If regard were had merely to the action of the enzymes, the interpretation *e.g.* in the case of plant life, would be mainly katabolic, for there is as yet no enzymic account of the building up of compounds with higher chemical potential, which is so distinctive a feature of life. The study of enzymes is the study of isolated, yet highly selective activities; each enzyme must fit its substratum like lock and key or the reaction does not occur. But the characteristic of the living cell is seen not merely in the connecting of one reaction with another, and in the using of the free energy of one reaction to carry on another, but also in the actual production of new enzymes to cope with new situations.[1] The cell initiates, directs, and co-ordinates the enzymic activities, but in the more difficult cases of metabolic change, as in the conversion of carbo-hydrates into fats, or of CO_2 and H_2O into organic compounds, energy is taken up from other sources, and this alone the cell can do. "This is the part taken by the living cell, which in one oxidising action obtains free energy, and in an accompanying reducing action stores this energy up, at least in part, in a new synthesised body at a higher potential of chemical energy than that from which it came. In this process enzymes may freely be used by the cell, but they are co-ordinated and regulated in the process."[2] All this fundamental metabolic activity, then, is in some way controlled for the good of the

[1] Czapek, *op. cit.* p. 100.

[2] B. Moore, in *Recent Advances in Physiology and Biochemistry*, p. 138.

individual, and in this directed control we have a distinctive character of life. And in particular aspects of it, *e.g.* the maintenance of body temperature in warm-blooded vertebrates, transfusion of materials through cell membranes, there is a regulation of process in the living form that is distinctive in the sense that it does not entirely conform to physical practice as known under purely inorganic conditions.

(*d*) As the result of these metabolic processes, corresponding products are organised in the plant and animal kingdoms, *e.g.* starch in plants and glycogen in animals, oxidases and trypsins in both.

In metabolism there are three great stages which may each be characterised by a single word—Absorption (of new material); Transformation (in the interior of the protoplasm) leading to Retention and Excretion. Protoplasm is found capable of absorbing or excreting matter either in a gaseous, fluid, or solid condition.

The differences between Metazoa and Metaphyta are based on broad lines, physiological rather than morphological. Animal and plant alike in virtue of their cell structure are composed of that fundamental linin-chromatic network whose functions are synthetic, contractile, and nervous. In the case of plants the synthetic function has dominated the other two in consequence of the unique way in which they obtain their food; in fact, the primitive contractile and nervous functions of the plant reticulum have shown no advance. As a result all the organic substance in the world is ultimately created by plants under the influence of sunlight. Animals, so far from creating, are continually destroying organic matter and resolving it again into its original components. The food of plants exists in a gaseous state in the atmosphere, or as salts in solution in water: it requires

therefore no preparation, and can be directly absorbed by the surface of the roots and leaves. The method of feeding is almost strictly chemical. But the food of animals, being organic matter, is usually in a more or less solid condition, which necessitates the presence of an internal reservoir in which the food can be stored until it is reduced to a more or less liquid absorbable condition. That is to say, almost all animals require a stomach, implying the development of muscle and nerve, and in the case of the Protozoa the whole creature functions as such for the time being.

Again, the food of plants is everywhere present. Every wind that blows brings food to the leaves: rain-water with salts in solution bathes the roots. Their food-taking is essentially passive. Animals have to seek their food—it does not usually come to them. Hence the nature of animal food requires that they shall have a definite mouth, a digestive tract, organs to carry the body in search of food, organs to seize it when found, and definite excretory organs to get rid of the waste. Free locomotion in the case of plants, apart from the Protophyta, is confined temporarily to the male cells, and with the absence of movement the function of sensation is at a minimum. Plants and animals thus differ in the nature of their food, yet both are dependent on the environment for supply, and that food when elaborated into "the physical basis of life" by contact with the living body shows little chemical difference as animal or vegetable protoplasm.

6. All living things exhibit cyclical phases of activity known collectively as a life-history, in which they manifest various degrees of vitality, sometimes with accompanying change of form. Every living creature, unicellular and multicellular alike, passes

through a regular cycle of changes, in part determined by forces within itself, to which there is nothing comparable in the inorganic realm. In the case of inorganic matter there is no reason why the same states and conditions should not persist or recur. With the living being this is absolutely impossible; it has a life-history, and such development precludes all possibility of rest or of the exact repetition of similar stages and conditions. Indeed, the extraordinary changes in the individual should make it easy to believe in specific changes. Such change is the mode of nature.

Reference has been made to a period of youth characterised in both cases by active cell-proliferation: the constructive (anabolic) phase of metabolism is then in excess of the destructive (katabolic), and the creature grows. This is followed by a period of adolescence in which, although at first the two phases practically balance, yet the energy of division sooner or later diminishes, and is accompanied by certain morphological changes in the cells previous to fertilisation—that process whereby the energy for division is renewed. This in turn—particularly in the case of unicellular forms, when fertilisation is not effected—is succeeded by the period of old age in which destruction slowly overtakes construction, and eventually the organism dies. The unicellular organism dies from protoplasmic senile degeneration just as surely as does the multicellular form. Now, this "capacity for death" is in a sense a distinguishing feature of living things. In a very real way, moreover, death is the servant of life, holding the balance between unlimited reproduction and limited feeding area. To it is due the circumstance that life is periodic in appearance: the recurrence of the living individual is a phenomenon unique in the

realm of nature. This intermittent character of life is, however, seeming only. The death of the individual that has reproduced by means of a germ cell divided from off its body involves no break in that series of continuous cell divisions which thus extends backwards to the dawn of life.

To this cyclical movement there have been supposed exceptions. L. L. Woodruff,[1] *e.g.*, has cultivated *Paramecium caud.* through more than 2000 generations during a period of 41 months, and considers that the varied culture medium with which these results have been obtained corresponds more accurately to the natural environment of the organism than the more constant media used by other experimenters which have usually proved favourable to conjugation. Considerations akin to these led Weismann long ago to speak of the "potential immortality" of unicellular forms,[2] meaning by this that natural death is unknown amongst them, being an incident connected with the transition to multicellular forms. Whatever may ultimately prove to be the scientific truth underlying the conception, it is obvious that the term "immortality" is a misnomer in this connection. Etymology even would indicate that immortality could alone be postulated of the *in*-dividual, whereas the Protozoa are essentially dividuals, lacking that in-dividuality without which in its most developed state immortality is inconceivable. If the Protozoa were really immortal there could have been no evolutionary progress, and the waters would ere long have been choked up with them.[3] If death had not

[1] *Archiv für Protistenkunde*, vol. xxi. p. 263.

[2] Cf. *The Evolution Theory*, vol. i. p. 260.

[3] It is calculated that one of the rod-like bacteria less than $\frac{1}{5000}$ inch in length multiplies in natural conditions at a rate which, unchecked, would within five days fill all the ocean to a depth of one mile with its progeny.

dogged the footsteps of life from the beginning, the Protozoa would have used up all the assimilable material, and no higher form could have come into existence by that way. Mortality is an essential prerequisite of immortality. In some cases of parthenogenesis a process of continuous growth is apparently strictly followed throughout the specific history, but again there is always, ultimately, death of the individual. In some of the higher plants and trees, construction seems to be continually in excess of destruction, and the tree may be said to grow as long as it lives: the plant is much less a "closed system" than an animal. Nevertheless, the individual eventually dies, even although, *e.g.* by grafting, perpetuation of the race may be secured without fertilisation.

Further, we may remark that not merely during those internal changes of every part that comprise metabolism, but in those changes of the whole that are involved in the conception of its life-history the living organism maintains a certain individuality and integrity. In spite of the constant metabolic change, in spite of growth and decay, the living organism possesses a more or less constant form which serves as the arena in which those changes are displayed. Thus, if from the combined points of view of irritability and metabolism, we think of the living organism as in a condition of continual specific change, its activity at any moment may be symbolically expressed by the formula $A \times B$, where A represents the first of a series of states $(A_1A_2A_3\ldots)$ of the organism, conditioned by successive states of the changing environment $(B_1B_2B_3\ldots)$. That is to say, any specific activity at any moment is to be considered as the resultant of two factors, its state at the moment under consideration and the aggregate of environmental stimuli or circumstances. This activity

in turn creates a new state (A_1) defined by what A was and what the reaction ($A \times B$) has been, which in like manner is modified by the changing environment (B_1) into a new activity (A_2). Now, in the case of the organism something remains all through—a specific type—expressed by A, A_1, A_2, etc. In short, we are aware of the maintenance of a state of dynamic equivalence between the organism and its environment which has, strictly, no parallel in the inorganic realm, and which within the organic kingdom increases in complexity the higher we rise in the scale of life. Continuously the organism is alive, and yet its material identity does not depend upon identity of matter. The matter changes, but the form remains more or less constant, the individuality usually even more so. These forms with their similarities and dissimilarities serve as the basis of classification. The fact that life shows itself always in some specific form would appear to negative completely the possibility of any merely chemical interpretation. This would involve an ultimate explanation of organic forms in terms of the arrangements of atoms and molecules. A leucocyte certainly has a chemical composition, but the fullest description of that chemical constitution will never give any necessary explanation of its form, still less of that of the organism whose vascular system it patrols. The chemical differences of the organs of the body are few compared with the difference of their form, and the diversity is greater still when we include the forms of life. Life is something more than the raw materials it employs. We may speak of life in general, but we never know it except as the special phenomena of a particular organism. Life clearly has unity or individuality at the core of its meaning, and in the scheme of nature, one of whose dominant features is a tendency

towards higher individuation, the supreme example is found in man, with his characteristic awareness of individuality, and the possibilities involved in its complete attainment.

The Evolution of Individuality is a study for the future, but already the broad lines of that movement are apparent. Water is always H_2O throughout the world. It may vary slightly in its chemical constitution, but any quantity from one source will always unite with any quantity from some other source. We can think of all the water in the world as a unity. A greater diversity exists *e.g.* in rock. Yet apart from a contour which is the result of external circumstances, there can be no individuality, and we can easily think of all the granite in the world as a whole, indeed of all the rocks as a single mass. But with regard to the realm of life even although all forms are of the same chemical constitution yet it is not possible to imagine a summed mass even of invertebrate life. Still less can we think the term humanity in the same corporate way as we can think the term rock, for the former is composed of discrete individuals whose very life is a protest against fusion in any single mass.

7. All living things are *capable of reproduction.* Having a definite term of existence, they must reproduce themselves, otherwise the organic kingdom would soon pass out of existence. The individual dies—life is intermittent in form—not, however, before having, in most cases, by a kind of discontinuous growth, given rise to forms more or less like itself, which in their turn grow and reproduce their kind. No non-living thing reproduces itself in this way.

(*a*) *Division.* The simplest form of reproduction is by division. The need for this arises in part directly out of assimilation. For the due interchanges (*e.g.*

respiration) between a cell and its environment, a certain ratio is necessary between surface and bulk. But this ratio is disturbed by growth in the case of an organism that retains its shape, inasmuch as, while the bulk varies as the cube of the diameter, the surface grows but with the square. Further, as we have learned, the nucleus which is so intimately concerned with assimilation, is limited in the area of cytoplasm that it affects through the continual intercourse between the two. Accordingly the requisite surface is gained through the division of the mass, and the mother cell loses her identity in that of the two daughter cells. Such reproduction accordingly takes the form of discontinuous growth. Growth, then, is primarily assimilation, secondarily division — the multiplication of cells. Division is a result of that expansiveness which is the very symbol of life. As such it is the normal method of increase.

Cell division in its normal condition in unicellular and multicellular forms alike is a highly complicated though rapid process, involving the actual splitting of the chromatin granules through longitudinal division of the chromosomes.[1] While a transverse division of the chromosomes could never have meant more than a quantitative division of their mass, it is possible that the longitudinal splitting involves a qualitative division. In the case of the linin reticulum those filaments which lie in or near the plane of division are split longitudinally, while those that lie at right angles to this plane and connect the centres, so to speak, of the future daughter cells simply lengthen and grow. This power

[1] This process of indirect nuclear division is usually called mitosis (Gr. *μίτος*, a thread) from the circumstance that the chromatin and linin elements first range themselves in a tangled skein which segments into the chromosomes (cf. Figs. 1 and 4).

of division, inherited from the precellular chromidial unit, we can only think of as a definite characteristic of life. As a result, every particle of the chromatin and, in great part, of the linin also, of the mother cell is equally divided between the re-organised nuclei of the daughter cells. At the same time it must be remembered that in the case of tissue formation and embryonic development such division of cells does not imply their absolute separation.

Although the process of cell division admits of simple description,[1] yet of the actual mechanism or of the energy at work we know practically nothing. Even more important are the issues of the first cell division. In a sense, the phenomenon is a repetition of the division of the precellular chromidial unit. A growth limit appears in the precellular unit, the cell itself, and, indeed, in all the higher subsequent units. But the possibilities of the cell colony are infinitely greater than those of the chromidial colonies, whose perfected example is the modern cell. When cells multiply and remain in such close association that not merely they enjoy the benefits of numbers (*e.g.* enlarged area of relationship with the environment) and incipient corporation, but a new type of organisation emerges as the result of the more intimate union of groups of cells to form organs, it is evident that an immense advantage is conferred on such an organism; in short, its life is on almost a different plane. Further, if this growth limit is an ultimate condition of things, then only by colony formation could any real advance have occurred at all.

A third type in which division appears as a characteristic of the living organism is the gastrula,

[1] Cf. E. B. Wilson, *The Cell in Development and Inheritance*, chap. ii., or other standard works.

a body-form found throughout the Cœlenterate group. This unit is a distinct advance upon the simple cell colony, and may not improbably be thought of as arising directly from a primitive syncytial network "by the formation of a large nutritive cavity, all the nuclei, during this process, crowding outward to form the wall of the sac thus produced."[1] An instructive parallel may even be drawn between this unit of the third order and those of the preceding forms which is peculiarly close in the fact of division of the whole individual as seen in the fission of well-known colonial coral types. Such fission seems later to have given place to the easier process of budding; and although no stationary forms with definite skeleton like the typical coral could have stood in the direct line of racial progress, yet in a linear colony resulting from posterior budding of such a free swimming gastræal unit the origin of the Annelidan type of life has been sought for, whose greater efficiency would lie amongst other features in its enhanced neuro-muscular digestive system, due to the fusion and integration of the units.[2] From such a type it has long been usual to deduce the primitive vertebrate, characterised particularly by concentration of the nervous system. The detail in such theoretic lineage tracery is considerable and must be sought for in the proper quarters. The insistence here is simply on the fundamental importance of division which with colony formation has resulted in a rhythmical advance of life.

(*b*) *Fertilisation.* Simple cell division, however, is only one aspect of reproduction. The culture study of Protozoa has shown that, with the possible exception

[1] H. M. Bernard, *op. cit.* p. 356.

[2] Bernard finds many points of contact between such a theoretical Annelid and the peculiar form Sagitta.

of some extremely low organisms, there comes a time in the life-history of unicellular forms when, after a greater or less number of ordinary divisions, it appears as if the cells were becoming worn out, were gradually shrinking in size after every such division, and showing signs of nuclear degeneration, so that a prospect of final extinction looms in the future unless they are able to fuse together in pairs with cells of different origin, thus producing an elementary organism that becomes the starting-point for a new series of multiplications by division. Accordingly, the life-history resolves itself into a cycle, the starting-point being furnished by any two cells which, after fusion, either separate and divide, or commence to divide as a single organism when fused, and continue so to multiply asexually, sometimes to the number of thousands of individuals, till what has been described as senile degeneration sets in. At this stage union of these cells with others of different origin is absolutely necessary for the perpetuation of the species. This process of cell union, of which, in those instances where the organisms latterly separate, the fundamental characteristic is a reciprocal exchange and fusion of nuclear substance—an exchange of experiences—between the uniting or conjugating elements, illustrates the simplest type of that second aspect of cell reproduction known as fertilisation.

Conjugation has of course been observed in a state of nature, but it is not altogether clear how far the conditions of artificial culture are causal in inducing the phenomenon. Equally artificial are the changes in culture environment to which *Paramecium*, for example, has been subjected in experiments tending to ward off conjugation and stimulate continued fission. But it is evident that the normal protozoan cycle must

be greatly extended, and it is just possible that under normal conditions conjugation is not so rhythmic a phenomenon as has hitherto been supposed.

In the higher forms of life, instances of parthenogenesis apart, we have a similar process—fusion of cells of different origin; here, however, the fusing cells never separate, so that the element of exchange drops quite out of sight. The essential feature of fertilisation is the union of a nucleus of paternal origin with a nucleus of maternal origin to form the primary nucleus of the next generation. This, however, does not mean that the cytoplasm of the gametes,[1] minimal as it is in the case of the spermatozoon, has no determining influence. Experimentation shows that hereditary characters arise apart from nuclear considerations, but the degree of the cytoplasmic influence in heredity is not yet very clear. In multicellular organisms the cells which result from the division of the fertilised egg remain associated together, thus forming a complex colony of cells, an organic individual, however, of a higher order than the *Volvox* community. In a sense this multicellular organism is morphologically comparable with the sum of the cells produced by asexual division from the two unicellular ex-conjugates. The cycle closes in the higher forms when the sexual cells have become mature, and separate from the parent to unite in the process of fertilisation, which forms the starting-point for the new generation of dividing cells. All this is a very complicated process in the case of the Vertebrates and Invertebrates, but in the lower multicellular Algæ it is simple enough. The capacity which every cell, *e.g.* of *Pandorina*, exhibits of helping to reproduce the whole multicellular organism is not seen when the organism is somewhat more highly

[1] *i.e.* conjugating cells which unite to form a zygote.

developed. For, in that case, the cells of the body[1] sooner or later become differentiated into two great classes the members of which Weismann has termed somatic and germ cells respectively. The former are of prime importance for the individual life, being differentiated into those various tissues which collectively form the "body." The germ cells, on the other hand, are of less significance for the individual life, but in eventually giving rise to new creatures are intimately concerned with the interests of the species. This differentiation is markedly noticeable so far down in the animal scale as *Volvox globator*. Amongst the very numerous cells that constitute a colonial form like *Volvox* some remain vegetative and others are transformed into reproductive cells. At the same time it is right to bear in mind that the distinction, even in the case of the higher animals, is only relative, since both sets of cells ultimately have a common origin in the fertilised egg-cell.

Further, a progressive differentiation not merely between the germ cells which unite in fertilisation, but in the type of individuals producing them, is also noticeable. In the simplest forms the conjugating elements are exactly alike to all appearance, yet already amongst the Protozoa differentiation has been established, perhaps even in the case of the *Paramecium* conjugates. The eggs of the colonial *Volvox* are large, and fertilised by minute biflagellate male spores that are produced in dozens by the division of a mother sperm cell; in the case of the sporozoon *Coccidium schubergi* the differentiation of the gametes is even more striking. In the case of the higher animals we have eventually two types of organisation producing

[1] Such a differentiation is already noticeable amongst the Protozoa, only here it is necessarily restricted to the nuclei, e.g. *Paramecium*.

two types of reproductive cell whose differing form and function have from the first betokened a physiological division of labour. The uniting cells must meet; this is ensured by the small, active, unencumbered sperm. A sufficient supply of nutrient material must be provided for the early stages of the developing life; this is supplied by the large, passive, yolk-laden egg.

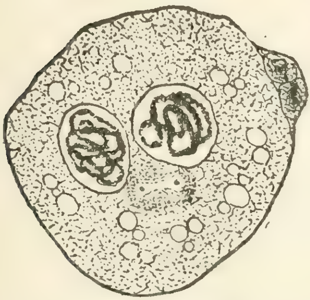


FIG. 4.—FERTILISED OVUM OF *ASCARIS*. — Male and female germ-nuclei, with chromatin at continuous thread stage: the centrosomes are separating. To the right are the extruded polar bodies. (From Walker's *Essentials of Cytology*, by kind permission of the publishers.)

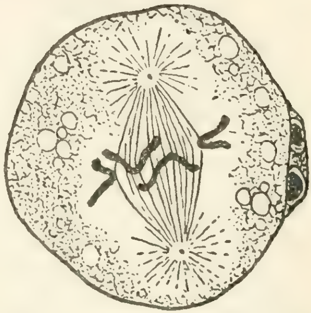


FIG. 5.—LATER STAGE IN FERTILISATION (*ASCARIS*). — The membranes of the germ-nuclei have disappeared, and the two chromosomes derived from each, four in all, have become attached to the spindle fibres. (From Walker's *Essentials of Cytology*, by kind permission of the publishers.)

The organisations that produce these differing types of cell we are in the habit of calling male and female respectively. But this does not necessarily involve any particular maleness in the one case or femaleness in the other—the unfertilised eggs of bees develop into males. In the organic world sperm and egg cells are derived from reproductive cells that initially are similar in size, appearance, and origin, but have become

differentiated through developing in different directions. Indeed, all the adaptations and associations connoted by the words male and female are secondary to the essential fact of fertilisation, which is the same in higher and lower types alike, namely, the union of equivalent nuclei: to this all other processes, and they are many, are tributary.

While certain experiments have been held to indicate that external conditions may in some instances determine sex, it is more probable that in the generality of cases the sex-determining factor must be sought elsewhere, and previous to development. In the case of certain species of insects, it probably takes the form of what has been described as an "accessory" chromosome. Demonstration has been made of insect species with two kinds of sperm—one with, the other without, the accessory chromosome. Its presence is also indicated in the egg cells. According as the fertilisation is effected by the first or second type of sperm is the resulting individual female or male. No analogous phenomenon has, however, been described outside this particular class, and even within it comparatively rarely.

Previous to fertilisation, a ripening process takes place in both spermatozoon and ovum, which is usually termed maturation. As a result of it, every male cell produced in the course of the process is capable of functioning, though this is not the case with the female cells, of which only one in four are potential egg cells. With maturation is intimately connected a reduction in the number of the chromosomes to one-half the number characteristic of the species: in this way a progressive summation of the chromosomes throughout succeeding generations is prevented. The procedure is very complicated and still imperfectly understood; but in the case of animals it is probable that previous

to the penultimate of the two final divisions by which the definitive germ cells are formed, the peculiar condensation of the chromatin (synapsis), and its appearance ultimately in a number of loop-like bodies corresponding to half the typical number of chromosomes, really represent in each case a conjugation of "homologous" paternal and maternal chromosomes which have hitherto remained distinct, and is followed by a reducing (meiotic) division in which they separate by dividing transversely, so reducing the number to half that which is characteristic of the species, but really also segregating the "homologous" paternal and maternal chromosomes into separate cells in varying combinations. This is followed by the final division producing mature gametes in which the chromosomes divide longitudinally as usual. Accordingly, the life cycle of the organism is after this fashion—conjugation of paternal and maternal cells, somatic divisions, and conjugation of paternal and maternal chromosomes. Every nucleus, then, arising by the segmentation of a fertilised egg cell contains a double set of chromosomes—nuclear substance derived from both parents. The centrosome is usually that of the sperm, as the egg centrosome degenerates after maturation.

The question of the individuality of the chromosomes has lately received very close attention. From a theoretical point of view the denial of their individuality seems to make mitosis meaningless. Why this careful and accurate division of the chromosomes if after every such division the substances of the different chromosomes are jumbled up in a common mass at nuclear reconstruction? The assumption of their stability likewise gives us the better explanation of their constant number. From the practical side Rabl, so long ago as 1885, maintained, as the result of study of mitosis in the

epithelial cells of the salamander, that the chromosomes do not lose their individuality between succeeding divisions, but persist in the chromatic reticulum of the resting nucleus. His idea was that the reticulum arose as the result of a transformation of the chromosomes, which gave off anastomosing branches, causing the temporary appearance of a network that was again lost as the reticulum contracted at various definite points to form the typical number of original chromosomes. Boveri, in particular, and others have further shown that whatever be the number of chromosomes entering into the composition of a nuclear reticulum, the same number issues from it at a later stage, and in very much the same position. This is particularly striking in certain abnormal cases of fertilisation, where it was noticed that the irregular number of chromosomes persisted from one cell generation to another, so suggesting that "the number of chromosomes appearing in a nucleus during mitosis is the same as the number of chromosomes from which it was originally formed."[1] The same result is apparent in cases characterised by an "accessory" chromosome. In certain species the chromosomes can be distinguished during the resting stage of the nucleus: and even if in most cases it looks as if the identity of the chromosomes was lost at this stage, yet this does not prove that it is so lost. In other species the chromosomes appear to show constant differences of size and shape, so suggesting that they may possess specific individual characters. In several cases (e.g. *Ascaris, Cyclops*) it has been demonstrated that the germ nuclei do not fuse, but that they give rise to two separate yet parallel series of paternal and maternal chromosomes that remain perfectly distinct, as far, at any rate (in *Ascaris*), as the twelve-cell stage,

[1] C. E. Walker, *The Essentials of Cytology*, p. 92.

and probably throughout life. Finally, as we have seen, associated with maturation there is a conjugation of "homologous" chromosomes which are later separated in the reduction division; and as a final result we have the separation of whole somatic chromosomes—data, all of which seem to imply a measure at least of persistent individuality. Here then, in general, is an important, if it can be absolutely demonstrated, an epoch-making discovery. With Harvey's name we associate the discovery *Omne vivum e vivo.* To Virchow we owe the induction *Omnis cellula e cellulâ.* Strasburger first clearly established the truth *Omnis nucleus e nucleo.* And with Boveri's name it is just possible that there will be linked the further truth that there are chromosome generations corresponding to cell generations; that the chromosomes of one generation arise endogenously in the chromosomes of a previous generation; that growth and reproduction, characteristic features of living things, are predicable of these intracellular units—in short, *Omne chromosoma e chromosomate.*

The further question remains of the relation of particular qualities to the chromosomes—how far they may be considered to be the vehicles of inheritance. The facts of the reduction division involve an alternative distribution of the chromosomes that evidently excludes the possibility of their being the vehicles of the common racial characters—unless, indeed, all of them are present in every individual chromosome. The distribution that takes place when the paired chromosomes separate in the reduction division prevents a half of every one of the chromosomes going to the resulting gametes. But teeth are found in every creature in which it is a racial character, and if that quality only resided in some chromosomes the reduction division

would imply its consequent absence in many individuals. On the other hand, if every racial character is present in every chromosome, it is not easy to see wherein lies the significance of a reduction division, or of the accurate longitudinal division of the chromosomes that ensures the practical reproduction of each chromosome of the zygote in every cell of the resulting body. Mendelism shows that certain characters are inherited alternatively, and certainly characters are associated with the chromosomes, though with which and how we may not yet say. Again, recent experimentation indicates that the cytoplasm, if only in a less degree, takes its share in the transmission of hereditary qualities. There is nothing to prove that this function is limited to the nucleus, and much is incomprehensible on any other supposition than that the cytoplasm—whose relations with the nucleus constitute the characteristic metabolism of the cell—has a sure though ill-defined share in heredity.

Fertilisation, then, is a process by which the energy lost in a continuous cycle of divisions is restored by the admixture of living matter from another cell. It entails the blending of two independent lines of descent, the actual union of two linin-chromatin networks. But when we go on to ask, What is the ultimate end of fertilisation? we not only ask a question involving that introduction of teleological considerations which is by many held to be the bane of Science, but we raise an inquiry to which, though many answers have been given, a completely satisfactory reply has not yet been formulated.

Fertilisation as involving rejuvenescence of the conjugating individuals might perhaps be thought of as a kind of mutual assimilation arising out of a specific sex hunger, whereby two cells exhausted and bereft of

essential elements of their economy unite, and out of the satisfaction is generated the energy of a new individual. It is not inconceivable that in the course of the long series of divisions the protoplasmic equilibrium of the dividing cells is upset, and that this is righted by the mutual attraction of cells lacking in and charged with specific qualities. In the case of the Protozoa conjugation certainly has this effect, for it is always the commencement of a new series of divisions; in fact, strictly it means the formation of a new individual in protozoon and metazoon alike. Weismann sees in it a means of mixing germ plasms whereby variations are produced and multiplied: these variations are the material upon which natural selection is supposed to work in the production of new species. This is for him the purpose of fertilisation, and carries with it the implication that forms produced by binary fission or parthenogenesis are practically duplicates. Considerable variation has, however, been shown to exist in the case of forms reproducing by binary fission and parthenogenesis;[1] consequently it is not permissible for Weismann to say more than that fertilisation is *a* source of variation, or is accompanied by it. Again, it is also possible to regard fertilisation as a means of checking variations, and so, on the contrary, of keeping the species true to the specific type. The offspring of biparental reproduction, instead of being more variable than either parent, is, so to speak, half-way between them, and so departs less widely from the mean than either of them. Indeed, the study of variation serves to indicate that, so far from producing new variations, biparental reproduction tends on the whole to eliminate such individual variations as are not directly the subject

[1] J. Y. Simpson, *The Relation of Binary Fission to Variation*; *Biometrika*, vol. i. No. 4; E. Warren, *Proc. Royal Society*, vol. lxv. p. 154.

of selection. In particular, under normal conditions all larger variations which are not present in both parents will tend to be diluted out: the useless variation is eliminated.

In any case, as the result of some form of stimulus consequent on fertilisation, the egg commences to segment. The individual cells or blastomeres, giving the appearance of isolation because of the concentrated nuclei packed around with nutritive matter, are yet in direct contact through strands of the linin network, which does not, however, prevent a certain amount of play of one cell upon the other. These cleavage divisions are similar to those that occur in ordinary cell division. The sole difference is that very early these divisions are accompanied by differentiation. Differentiation in the higher forms of life is expressed in the establishment of tissues and later of organs in connection with that physiological division of labour that usually means so much greater capacity for doing special work. The more complex the organic structure the more detailed is this subdivision of labour: the greater the degree of co-ordination and unification of these activities, the higher the creature stands, as a general rule, in the scale of life. How all the different stages have arisen with their genetic continuity is the story of evolution, most interesting, if most difficult, in the lower grades of life, where, however, modern study, *e.g.* of the Protozoa, sheds floods of light upon the question. In the course of this differentiation considerable change is often noticed in the functions of the organs—what at one stage played one particular rôle is found at a later stage to function in a different manner.

Again, the cleavage divisions of the developing egg are often effected in planes that show some definite

relation to the structural axes of the adult body. Typically the cells tend rhythmically to divide into exactly equal parts, and any new plane of division tends

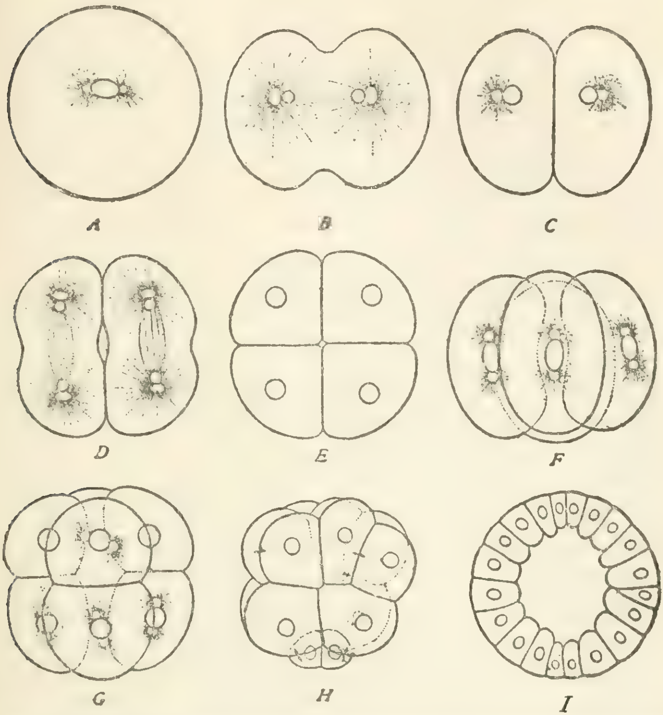


FIG. 6.—CLEAVAGE OF THE OVUM OF THE SEA-URCHIN TOXOPNEUSTES ($\times$ 330). The successive divisions up to the 16-cell stage (H) occupy about two hours. I is a section of the embryo of 3 hours, consisting of approximately 128 cells surrounding a central cavity. (From Wilson's *The Cell*, by kind permission.)

to intersect the preceding one at right angles. Variations, however, occur not merely in the rhythm and in the quantitative character of the divisions, but also in the direction of the cleavage planes; these variations are

often of regular occurrence. Not merely do the cells divide in accordance with the requirements of definite mechanical conditions, but also and more distinctively with reference to the future cell orientation and structure of the animal. The framework of the human liver, for example, is developed from the mesodermal layer of the embryo; the hepatic cells have their origin in the endoderm. "To bring these two structures together to form a liver implies growth from different points and at the proper time."[1] Of this forward look, as of the unequal division that sometimes sets in as early as the first segmentation, and in every case appears sooner or later, no sufficient account has been offered. In fact, as Wilson puts it,[2] "we cannot comprehend the forms of cleavage without reference to the end-result." Study of all purely mechanical factors, such as pressure, form, etc., only makes it more obvious that the work is subordinated to that of some superior controlling law of growth.

How far the later structure of the developmental form is already determined in the structure of the egg is the root problem of Embryology. In many cases a definite relationship appears to exist between early blastomeres and the later adult areas to which they give rise: in other cases, again, it becomes evident, particularly as the result of experiment, that there can be no definite, unalterable pre-localisation of parts of the egg. In several cases the egg axis is not established until after fertilisation, and is even then experimentally alterable. But no general consideration holds in any number of cases. Cell formation and localisation of areas seem, ultimately, alike subordinate to some controlling formative process that expresses

[1] J. G. M'Kendrick, *The Principles of Physiology*, p. 51.
[2] *Op. cit.* p. 377.

itself in growth. Development takes the form of an orderly correlated progress towards a definite end. The egg in each case in a remarkably short time evolves into a type about which certain general statements can be prophetically hazarded, but of the inwardness of this process no account can yet be given. To speak of developmental capacities as being involved in the organisation of the egg is, perhaps, effective, but not informing: at the most, any accurate descriptive account of the stages is all that is within the power of the biologist.

The idea of pre-determination or pre-localisation of embryonic parts in the fertilised (possibly even in the unfertilised) egg cytoplasm has fascinated many workers: not, of course, in the crude sense of the early evolutionists, who maintained the existence of a preformed though invisible embryo, or even in some cases a miniature of the adult in the egg, but in the more general sense that definite areas, perhaps definite substances, in the apparently homogeneous cytoplasm correspond to definite parts which will later be built up out of them. There are a great many facts that serve to indicate that the cytoplasm has considerable and sometimes specific regulative control in development. Segmentation would then simply reveal what is already predetermined. On the other hand, identification of the physical basis of hereditary with nuclear material demands that such cytoplasmic pre-localisation—if it exists—must be determined and controlled from the nucleus; and the attempt has been made, notably by De Vries and Weismann in their respective theories, to transfer the assumed germinal localisation from the cytoplasm to the nucleus. The differentiation corresponding to later embryonic regions, which is early noticeable in the cytoplasm, is induced secondarily

through the influence of the ultimate nuclear units that migrate into the cytoplasm and direct its development. In Weismann's theory, development resolves itself into the gradual qualitative distribution of these units from their massed condition in the early cells, until at last in each cell there is simply left that particular determinant which controls it. But of these qualitative divisions, save, perhaps, in the reduction division in maturation, there is scant evidence. On the contrary, certain facts connected with regeneration, and the ability of a single cell of the two or four cell stage to reproduce the whole embryo (*Amphioxus*, *Echinus*), although on a reduced scale, distinctly negative it. Further, in the cases where, as in the frog, the right cell of the two-cell stage appears to contain the material for the right half of the body, that cell if isolated can yet in great measure supply the deficiency by a peculiar kind of regeneration.

If, then, there be no qualitative distribution of the chromatin, if, on the contrary, it be equally distributed at every cell division, how is the differentiation accomplished? Driesch has suggested that the answer lies in part in the relation of a blastomere to the remainder of the embryo. "The relative position of a blastomere in the whole determines in general what develops from it; if its position be changed, it gives rise to something different: in other words, its prospective value is a function of its position in the whole."[1] The suggestion bears a true relation to what does occur in many instances; but it is evident that not merely the position of a blastomere to its neighbours, but the position of its own constituents have to be considered, for Morgan has shown that even in the case of the two-cell frog the single isolated cell may give rise to a whole embryo of half size, as in *Amphioxus*, or a

[1] *Studien*, iv. 39.

half embryo, according as the isolated cell is turned upside down or left in its normal position. This seems to indicate that all the material for a complete, if half-sized, embryo exists in the single cell of the two-cell stage, and that at this stage, as in *Amphioxus*, the blastomere is not so firmly set that it can only develop into the half of the creature that normally it would. In fact, embryology discloses a whole series of forms in which this equivalence of the isolated cells at the early stages is greater or less, some easily overcoming the tendency to develop only (as normally) into a part, others doing so with greater difficulty, and even failing, with the result that a monster (defective larva or adult) is formed. Accordingly it would seem as if in every case, even though we may have to go back to the prematuration stage, the egg cytoplasm is primarily equipotential in the sense that the various regions do not stand in a fixed relation to parts that may develop out of them, but that sooner or later differentiation of these regions, resulting in a mosaic-like development, does take place from causes that we do not understand—sooner, as in the case of the mollusc *Dentalium*, whose single cells when separated cannot completely overcome the tendency to form a part, and develop into monsters resembling pieces of a single embryo (and the same result is achieved by artificially cutting off pieces of the egg); later, as in the case of *Amphioxus*, where a cell of the two-cell stage or the four-cell stage may develop into a complete dwarf adult, either half or quarter size. A suggested solution of this phenomenon consists in assuming the various protoplasmic constituents as arranged in bands or zones.[1] In *Amphioxus* the first division would divide these symmetrically and equally.

[1] Cf. E. B. Wilson, *Science*, vol. xxi. No. 530.

In *Dentalium* the division may be apparently symmetrical but really qualitative, so that all of one band or zone passes into one of the cells.

Further, it is difficult to surrender the belief that differentiation of a kind, slight perhaps but still effective, has occurred much earlier, even previous to fertilisation, for the egg has a developmental history antecedent to that experience. These axial differentiations are probably due to the nucleus, and form the scaffolding as it were within which the development after fertilisation goes on. The ability to readjust displayed by the isolated blastomeres largely depends on the degree to which this scaffolding has been effectively reared.

At the same time it must not be forgotten that this ability of the cells of an embryo to reproduce the whole organism is confined merely to the earliest stages of the developing form. Cells do become differentiated, and this seems to imply nuclear differentiation of some sort, even if not after the manner of qualitative division. It is possible that part of the chromatin may be cast out of the nucleus, or dissolved, or be transformed into something else. The former circumstance has been indeed observed in the early somatic cells of the developing *Ascaris* by Boveri. Driesch's conception of the nucleus as a "storehouse of ferments which pass out into the cytoplasm and there set up specific activities,"[1] is at least interesting. Certain it is that "specific protoplasmic stuffs" are distributed to the cells in a definite manner during division; and since they have a definite arrangement in the egg, to this extent development is mechanical, and "the cleavage mosaic is an actual mosaic of different materials that are somehow causally connected

[1] Wilson, *The Cell*, p. 427.

with the development of particular parts."[1] If it could be shown that initially protoplasm contains only a few of these specific stuffs, that as development proceeds new stuffs are progressively formed and distributed, and finally that their number decreases and that they weaken as differentiation progresses, we should have an interpretation of development that is essentially epigenetic—progressive in the sense that new additional parts not already there are formed: and in this combination of the two older and contrasted view-points of preformation and epigenesis, the truth is probably to be found.

With all this we must not forget the dominating rôle of the environment in all development: without its stimuli the inherited organisation of the living creature would not work itself out. The living form is at any moment the resultant of external stimuli acting upon its inherited organisation. This has been experimentally proved time and again. A normal development is the response to normal conditions. In the case of the humbler forms of life the character of the response is mainly determined by the inherited organisations. As life advances, the inherited organisation counts for less and less until in man the environment has the last word. The developing organism and its environment react the one upon the other independently; yet in virtue of its adaptiveness the organism is progressively able to set itself free from the control of the physical environment and proves itself the more victorious of the two. Their separation is, however, practically impossible: we are almost compelled to consider the organism and its environment as a single system undergoing change.

In conclusion, we reaffirm that in that marvellous

[1] Wilson, *Science*, vol. xxi. p. 288.

co-ordinating power that guides individual development rhythmically and orderly to its goal we find that which is ultimate. Of its existence there can be no doubt, for we have become aware of it at many points of our biological study. We see it in various adjustments and regulations that characterise outstanding features in metabolism, *e.g.* the maintenance of a practically constant quality and quantity of the blood. We see it in the wide range and intense specificity of the relations that are involved in immunity.[1] We see it in the segregation of distinctive cells for the modified repetition of the parental history. We see it further in the marshalled progress of these cells to a distinctive and predictable end in the production of a complex organism functioning as a unity, and that in spite of their proven capacities at least in the early stages to serve in other ways, in spite also of the appearance at later stages of localised self-differentiation and independent development. And particularly is it evident in those pathological cases where, after artificial re-arrangement or destruction of some of the cells at an early stage in development, the particular destiny is yet harmoniously achieved in a way that excludes the crude conception of an underlying mechanism. What this ordered control is in itself we have no knowledge. This autonomous control and guidance for a definite end—the typical adult form of the organism—is that which rides athwart the various forces at work in the arena of the living form, non-factorial, yet uniting all other factors; it is that wherein livingness consists. In any description of organic phenomena, as we have seen, we find ourselves treating of physical phenomena, osmosis, surface tensions and so forth, but though they

[1] H. Driesch, *The Science and Philosophy of the Organism*, vol. i. pp. 204–209.

enter into the account, they do not account for life. Indeed, they are simply in its employ. We fling the fine-drawn network of our physical and chemical concepts over the living thing, thinking that we have encompassed it, but it comes oozing out through the meshes and cannot be held, for it is subtler than all our thoughts of it. As Wilson puts it, "we no more know how the organisation of the germ-cell involves the properties of the adult body than we know how the properties of hydrogen and oxygen involve those of water."[1] In the case of the individual history whereby the acorn develops into the oak and not into an elm, and the fertilised egg of the butterfly travels by a wondrous road to its destiny and not along any of the other 250,000 insect routes, we may marvel at this power; but in the history of the race where the steps have been infinitely greater and the time element immensely longer we behold it in greater glory.[2]

[1] *Op. cit.* p. 433.

[2] As these pages have been passing through the press, attention has been focussed on some of the problems discussed in them, as the result of the masterly address of the President of the British Association for the Advancement of Science, 1912. In it the opinion is hazarded that "the possibility of the production of life—*i.e.* of living material—is not so remote as has been generally assumed," while the conclusion is held to be "forced upon us" that "the evolution of non-living into living substance has happened more than once—and we can be by no means sure that it may not be happening still." The fact, however, that life in its simplest manifestations always shows organisation,—which is more than structure,—together with all that is implied in the conception of a history of life, viz. that not merely life itself but the environment of its production and evolution have been correlatively subjects of a broadly progressive change, makes it difficult to conceive that life will return upon itself, so to speak, even in the laboratory of the experimenter. No form of life once extinct has, so far as we know, again appeared, and only in the most superficial of aspects can it be said that history repeats itself.

CHAPTER V

EVOLUTION

In the varied modern uses of the term Evolution we may see an interesting example of a word outgrowing and outliving its original significance, till it has developed a wealth of connotation that embraces the universe itself. Originally, the word Evolution was applied to a specific theory of the origin of the individual life which was held by certain eighteenth-century naturalists. They believed that every egg contained a preformed invisible rudimentary structure that corresponded, part for part, to the adult form. Thus development was the unfolding and transformation of a pre-existing structure, not the successive formation of new parts. Just as one day the tightly closed sepals of the green bud unfold and disclose the coloured stamens and petals that have apparently been growing under their cover from mere miniatures in secret, so did the old evolutionists (or preformationists) consider that the diminutive transparent parts of the germ gradually grew until the day of their manifestation to the outer world. To this theory the name of Evolution was given. Observation quickly showed that no such simple growth took place, and a more correct view was enunciated in the rival doctrine of Epigenesis, viz. that development was no mere unfolding of parts already existent, but the gradual

and continual formation and differentiation of structures and organs not previously existent as such in the egg. The word being useful, however, was retained to express the idea of development in general, and while originally applied to the growth of the organic individual, whether plant or animal, from the egg, was soon employed in connection with the development of features related to human life, such as language, political constitutions, etc., and has even been transferred to the realm of the inorganic, and finally to the process of the universe itself. Such transference is not a recent movement. Swedenborg and Kant indeed held theories of Cosmic Evolution though not in name, in the types of nebular hypothesis associated with them. To-day, on the other hand, modern physics is specially busied with the evolution of the atom and the transmutation of the elements. Organic evolution occupies but a moment in inorganic evolution, which has been the immensely longer process; yet we are not prepared to consider the latter as therefore the more inclusive process as it were, or to think of the former as but an incident in the latter.

In all these varied processes of "becoming," the root idea is that of change. Evolution is the history of changing forms, organic or inorganic, as affected by unchanging laws. The process of inquiry has been marked by the persistent dissipation of associations of permanence with the material—planet and atom alike prove to be unstamped with it—and by the emergence of conceptions of spiritual energy as that which alone endures. When inquiry is made into the character, direction, and ideal significance of these changes, we go beyond the merely descriptive account, and the facts of Evolution become the basis of a philosophy.[1]

[1] As, *e.g.*, Herbert Spencer's Synthetic Philosophy.

The facts of change have only been gradually appreciated in their tremendous significance. Nothing organic or inorganic is as it was half an hour ago, even as no one dipping his hand in a river can be twice wet with the same water, and all these changes are greater than they appear. We recollect the old-time dictum that the substance of the human body is entirely changed within every seven years, but a 24-hour record of a human life in a scale pan would show a continuous oscillation of level, corresponding to the varying weight in body. To-day we have learned to extend these records of change past the individual life to that of the species, the class, the race. Yet fixity of type was the catchword of science in the middle of last century; the everlasting hills are still the joy of poetry. "I believe," said the rose to the lily in the parable, "I believe that our gardener is immortal. I have watched him from day to day since I bloomed, and I see no change in him. The tulip who died yesterday told me the same thing."[1] Because of the shortness of human life compared with the duration of the world processes men spoke of individual things, even of species, as permanent—as if a child should gaze at a clock for a moment and roundly declare that the hands stood still. Brief as the lightning flash with its momentary revelation of seeming repose amidst the agitation of a stormy night, is the life of man compared with the chronicles of life in Nature. Similarly under the casual flash of his untrained intellect the phase of nature amidst which man momentarily moved, appeared to him unchanged and motionless. From this illusion in part there arose the theory of the permanence of type, an illusion that still persists in the tendency to consider the pheno-

[1] Quoted in D. S. Jordan's *Footnotes to Evolution*, p. 56.

mena of heredity as more fundamental than those of variation.

Most commonly the term Evolution is used to denote that theory of organic existence which accounts for the origin of organs and of species by divergence and development from ancestral stocks, or, in a narrower sense, maintains that all the forms of life now existing or that have existed on the earth have sprung from a few primitive forms, possibly from one. This theory was at first merely a working hypothesis, but all contrary hypotheses have long since ceased to work. Its success particularly in explaining many phenomena of detail that are otherwise inexplicable has been especially impressive. Things are because of their significance, and like some new Rosetta Stone, Evolution supplies a key to numbers of hitherto undeciphered data. All modern biological investigation assumes its truth. In fact, no naturalist whose studies give him the right to an opinion on the origin of species now holds the older views: he could not do so and "look an animal in the face."

In ordinary usage the terms Evolution, Organic Evolution, and Theory of Descent are often employed synonymously, but it is important to note that the term Evolution is not strictly equivalent to the unfortunate word Darwinism. Evolution is a theory as to the general method by which species have been introduced into the world, independent of any idea as to the causes or agencies which have brought about their introduction. Darwinism is Evolution, but it is something more; it is at the same time an attempt to explain the causes of Evolution. It not only claims that species have been slowly evolved from one another, but particularly in Natural Selection, as also in Sexual Selection and the theory of Pangenesis, it

offered some account of the manner in which they have arisen and of the laws which govern their gradual modification. Accordingly it is possible to accept Evolution and yet at the same time to reject Darwinism, *i.e.* it is possible to believe that species have been evolved from each other, but to deny that Darwin suggested a sufficient cause for this Evolution.

This distinction with its implications should be clearly grasped, as otherwise it is difficult to appraise correctly certain extreme statements that creep into modern biological literature. Thus E. Dennert entitles a book *Vom Sterbelager des Darwinismus.* Von Uexküll writes: "We stand on the eve of a scientific bankruptcy, whose consequences are as yet incalculable. Darwinism is to be stricken from the list of scientific theories."[1] Or, again, "Concerning the origin of species we know, after fifty years of unparalleled effort and investigation, only the one thing, that it does not take place as Darwin thought it did. A positive enrichment of our knowledge has not resulted. The whole enormous intellectual labour was in vain."[2] Such intemperance of language is unscientific, whatever else it may be, and can only prejudice the case in whose interests it is uttered.

In any discussion of the relations of scientific and religious thought, Evolution will find a place if only because of its potency as a unifying agent in the world of data. The conception of the unity of knowledge naturally suggests the idea of foundation lines along which this stately temple shall be built. Such a foundation line is Evolution, extending so far as is known through every department of knowledge, and offering a beautiful example of the mutual benefit

[1] *Scientia*, vol. iv., No. 7, p. 3.
[2] *Zeitschrift f. Biol.*, vol. l. p. 168.

to one another of the scientific and the theological outlooks on God and the world. For while in its light the scientific theologian has reached in some respects a nobler and a purer conception of God, he can also show that without the inclusion of a purposive factor it can in no sense pretend to completeness or satisfaction as the story of the world. For him intention is the bond that binds him to nature and links both with God; the world that he inhabits is a "realm of ends." In Evolution men have come to perceive God's method of creation in time, even as gravitation deals with the relations of things in space. It forbids us any longer to think of the world as of some structure carpentered at a definite point in time; rather does it teach us to look on it as a growth. The Paleyan symbol was a watch; the type of Evolution is a flower: and while the watch stopped more than half a century ago, the flower is still a living, reproductive, progressive, and didactic thing. From it we learn that progress is gradual, "first the blade, then the ear, after that the full corn in the ear;"—that is Evolution in the individual life. It teaches us in a way that we had not realised before, that the present is the child of the past by direct descent, and that the future has its roots in the present. It makes us regard revolution as unnatural, and it also shows us that reformation may be very slow. It compels us to take a larger view of things—not to estimate the stream of life by the little circling eddies, nor yet by the contrary surface currents such as may often be seen on mile-broad Asiatic rivers, but by the whole flood, grand, full-watered, irresistible, as it sweeps towards its ever-nearing goal. There are, of course, the eddies, for advance in any given direction may not be uniform; there are the backward surface currents, for palæon-

tology tells us of apparent recession in the progress of individual species; there are the rapids, for successive strata sometimes disclose a quick advance in the development of forms under congenial circumstances; there are the pool-like, seemingly motionless tracts, for we have evidence of partial temporary stagnation in the otherwise progressive movement, of genera that often rested, marking time in the age-long march. We must not judge the stream by the eddy or the counter-current, by the rapid or by the pool-like tract, but by the whole course.

Evolution accordingly may be defined[1] as a process of continuous, orderly, and broadly progressive change, from the simple to the more complex, which arises as the resultant of various factors, operating from within and from without. Typically we see it in all embryonic development, that marvellous process by which a fertilised egg-cell grows by segmentation and concomitant differentiation into an organism of its own species. In the development of the hen from a microscopic germ-cell through the intermediate stage of the chick into the adult, we have an instance of continuous, orderly, and broadly progressive change, from the simple to the more complex, which arises as the resultant of various factors operating from within and from without.

But the statement implies more than at first appears. Evolution is change with continuity.[2] This we know to be the case in every instance of individual development. Bird and beast, fish and creeping thing, man himself, all begin life as a single cell—commence where the Protozoa left off—and so pass through

[1] This definition is a modification of that set forth in Le Conte's *Evolution and its Relation to Religious Thought*, p. 8.

[2] *i.e.* of content, rather than of time.

many different stages into the adult organism of their kind. In this instance the terms of the series obviously have genetic connection. With regard to that other series, so imposing in its grandeur, beginning with life itself in the far-back pre-Cambrian days and comprehending all the countless forms that have peopled Primary, Secondary, Tertiary, and Quaternary eras — forms likewise growing in complexity of structure, in the mutual action of their correlated parts, and in their inter-action with the environment—the evolutionary suggestion is that its terms likewise have a genetic connection, and leave their impress on the individual series.

If Evolution implies continuity, it is inconsistent with the idea of "breaks" in the succession. A clear understanding at this point would mean the solution of half of our difficulties. Everything of course will depend upon the content of the word "break." When the temperature of water is raised from 99° to 100° C. under ordinary atmospheric pressure it vaporises: in a certain sense there is a "break." The study of mutations is a study in "breaks." Yet whatever be the series, organic or inorganic, every term is in some degree linked to that preceding it. Something from a preceding stage is always carried over to the next. There is never absolutely complete initiation. If creation is held to mean production out of nothing, initiation without any precedent relation, it is an effect that is contrary to all experience and in which there is nothing of Evolution. Such absolute "breaks" are commonly cited at the commencement of the evolutionary process, at the dawn of life, at the appearance of sentiency, at the awakening of self-consciousness. An older apologetic filled in the "breaks" with divinity, but what it fondly considered to be its

strongholds proved its most vulnerable points. The difficulty about these "breaks" is that they are supposed to occur at periods about which we have no knowledge, and of which we can never hope to learn the exact conditions. Thus Principal Chapman's "vast diffusion of ultimate units of Matter, each like the other in every respect, each subject to equal pressure and tension,"[1] awaiting some divine contact—some breath, some touch—to start it on its evolutionary career, is wholly hypothetical. With regard to the dawn of life it does not follow, as has often been pointed out, that although Biogenesis is the only known law of reproduction now, the conditions requisite for Abiogenesis have never occurred. We cannot say definitely what these conditions were, yet we can be tolerably certain that the lands and, particularly for this purpose, the seas of late Archæan times were very different from any modern conditions, terrestrial or marine. They are conditions that will never return, and are not humanly reproducible. The belief in such a natural origin of life is an exigency of thought. Again, if the term is employed in its broadest significance, the appearance of sentiency, *i.e.* irritability, synchronises with the dawn of life, and another break has been removed. We are left with the awakening to self-consciousness. But even this crisis presents no difficulty to the modern scientific mind: as a matter of fact, it is actually bridged in the development of every child.[2] No, there have been no breaks. Evolution is continuous change; it is continuity, and God has been immanent from the beginning. In the process there is a great deal that

[1] C. Chapman, *Preorganic Evolution and the Biblical Idea of God*, p. 151.

[2] Cf. p. 310.

is little understood, and much that is unknown, but the days are past when the unknown, the gap in our knowledge, is emphasised as the sure abode of the divine. Rather is it realised that the whole process is instinct with divinity, and nowhere is it more obvious to the religious philosopher than in the great fact of direction in general and in detail which compels him to insist on the recognition of a directive factor in opposition to all ultra-mechanical conceptions of Evolution. To recognise the spiritual aspect of Evolution is to believe in it as directed by an over-ruling yet indwelling purpose, a process with no breaks but of rare continuity and yet with "increments,"—crises greater in their implications than in the actual moment, points after which everything thereafter moved in a new dimension, as in the birthday of life,—flood plains of the river of life which marked successively higher contours in the regions of the world's action, as in the dawning of self-consciousness, and the appearance of Jesus Christ.

But it is more: it is continuous, orderly change. The order is the expression of what is often called "the reign of law." In science the connotation of the term is very different from that which jurisprudence attaches to it, and in consequence of this ambiguity some writers have been led into strange confusion.[1] In the latter sphere we associate with the word the conception of something "(1) expressible as a distinct proposition, (2) addressed to the will of a rational being, and (3) enforceable by a sanction."[2] In the realms of science the idea is quite otherwise: there it appears as an abstract or general conception of a supposed uni-

[1] For examples see article "Law" by Prof. Hearnshaw, *The Hibbert Journal*, vol. vi. No. 3.

[2] Holland, *Jurisprudence*, p. 21: quoted by Hearnshaw.

versal uniformity of action deduced from the observation of illustrative phenomena in a limited number of instances. In formulation a law of science should always take a conditional form,—if such and such conditions are present, such and such results will follow. Nevertheless, the law is simply a generalised statement, a conceptual shorthand report of Nature's observed uniformities of action, and never can be anything else than a more or less provisional hypothesis to minds experimentally less than omniscient. The confusion arises in identifying the ascertained sequences themselves with the law, whereas it is but a statement of them, or in hypostatically conceiving the law as the energy or force in virtue of whose uniform operation the observed regular sequences take place, and so subjecting phenomena to it, as if the law were an objective determining agent. From this it is but a step to carry natural laws behind things as it were, and regard them as pre-existent necessities which explain everything but are themselves in no need of explanation. Strictly, however, we know nothing of what is necessary; our knowledge is simply of what has been proved to occur under specific conditions. Natural laws may apply in any particular series of circumstances; they do not, however, necessarily *im*ply. According to Newton's Law of Gravitation, every particle in the universe attracts every other particle with a force which acts in the line joining them, and which is directly proportional to the product of the masses, and inversely proportional to the square of their distance apart. Why might it not have been inversely as the cube of the distance? A natural law is simply the expression of a relation: it is not the relation; still less is it its cause.

In the article referred to, Professor Hearnshaw shows

how in the moral sphere both senses of the term find application, and call for even greater care in discrimination. Moral law appears both in the form of sanction —enforced precept—and uniform sequence. "Pray without ceasing," says Paul:[1] "This is the confidence that we have in Him, that, if we ask anything according to His will, He heareth us," says John.[2] The deepest sanction arises from recognition of the results of such uniformity in human life, and when one reflects on the *Cause* of the uniformity, the latter in its results comes to take on the form of an implied command. And inasmuch as no series of sequences ever makes a law, this aspect of law as that which is commanded or ordained becomes ultimate. The affirmation of natural law is the affirmation of something more than mere series of sequences: it is the acknowledgment of a persistent and sustaining cause of these sequences, which we are driven to find in the Divine Energy itself — energy expressive of and emanating from the Divine Will. But this Will in turn is but an expression of the divine mind, so that the "reign of law" merely comes to be the physical counterpart of the divine immanence. The physicist looks at the data and says, "It is all law": the philosopher ponders them and concludes, "It is all mind": but the greatest induction is that of the man who has lived through it all, noting the resultant of the various sequences in the case of his own experience, and who can truthfully say at the end, "It was all love."

We have already seen that the advance of science consists in the recognition of ever increasing numbers of these grouped relations which in their constancy and interaction elicit our admiration. They are the result of processes all of which are natural, and it is the ideal

[1] 1 Thess. v. 17. [2] 1 John v. 14; cf. also 1 John iii. 22.

of science to give a complete account of them all. The creation of man or the growth of a state are as much natural processes as the flowering of a lily or the growth of a sand dune. And all are supernatural in the sense that they are alike expressions of the invisible solidity of the universe, the immanence of law, and the imperishability of energy. Science has her ideal, but however much we may feel doubtful as to the ability of the human mind to realise all the laws, for example, of the science of life, yet we are none the less sure that these laws never fail. This very uniformity, however, the basis of all scientific endeavour and the comfort of the religious mind,[1] has in many cases by a curious inversion proved the greatest stumbling-block to religious faith. To such minds the only proof of Deity for an age of scepticism would be to see a law of Nature definitely broken, to see *e.g.* a real burning bush unconsumed, and so have it demonstrated that the energy that expresses itself in law can also show itself in lawlessness, and so prove itself superior to all its limitations and usual epiphanies. Thus in the confusion a false emphasis is laid upon the miracle. The most the miracle can do is to draw attention to the eternal truths with whose promulgation it is associated. These truths relate in part to the essentially spiritual character of the world, and once this has been grasped the individual miracle becomes but an episode in the greater miracle of the whole. I have seen it somewhere remarked that Emerson in one of his Essays speaks of a man's purpose in life "to be sound and solvent," and Emerson's life at any rate seems to have had this character, whence we may conclude that such a rule of conduct was his own. "But one may say 'This is only a human resolution. The man himself should be

[1] Heb. xiii. 8.

above all rules and requirements of his own making. Let Mr. Emerson show that his life is above his principles. Let him break these rules to show his power. Let him be unsound and insolvent for a time. Then only will his real greatness appear.' But the soundness and solvency were the expression of Emerson's life: without these he would not be Emerson."[1] In like manner the laws of Nature are the expressions of the soundness and solvency of the Infinite Energy. A broken law would be the expression of unsoundness and insolvency. It would mean the failure of the universe: in that sense law can never be broken. The demand of those who would see broken laws is the same as that of the old Pharisees for a sign. And no sign shall be given them. For the man who cannot see the touch of divinity in the life-activity of the cell or in the autumn colouring of leaves, who cannot realise the majesty and power of God in the order and uniformity of Nature, who cannot so put himself in sympathy with Nature that Christ's words concerning her seem to him instinctively words of truth, and so words of God because they are the words of truth, has injured his soul and will not believe though one rose from the dead, still less *that* One rose from the dead. To demand such interference is to go back to the early Israelitish conception of a capricious God. And yet we do not say that God does not interfere. Man interferes with the order of Nature, and what is possible with man may well be possible with God. Man interferes, but ever in obedience to other laws. And so may God interfere, but in no lawless way: rather through the medium or superposition of laws other than those that are already open to our comprehension.

[1] D. S. Jordan, *op. cit.* p. 61.

Again, many are distressed because of the apparent insensibility of Nature. She goes on with her own affairs. Mont Pélée's fiery flood envelops sinner and saint alike: Messina falls on the just and on the unjust. Yet this attention to her own affairs, this "just keeping on the same," as we say, is simply the expression of the solidity of the universe. A law of Nature is no respecter of persons, nor an executor of human justice. Just as a varying multiplication-table would be the destruction of mathematics, so would a varying law of Nature be the destruction of the universe. Constituted as man is, life would be impossible even for a day if there were no basal uniformity of Nature: without it experience would be valueless, there could be no knowledge, no inducement to labour, no pabulum for faith. Not otherwise could Nature have ever been an orderly and beautiful means of intercourse between man and God. And even where a temporary phase of Nature's process seems to man to take the form of a disaster, it might be well to inquire whether that principle of judgment is soundly and broadly based which condemns that which has hurt him. For if in some inscrutable way men were at the eleventh hour rescued from the consequences of some natural process they would have gained their preservation at the cost of their lost sense of law; they would feel themselves the victims of chance, and much of the motive for right conduct would be gone.

With regard to Messina we must realise that given the world as it is—and the real understanding of what it is more than removes the difficulty—such a catastrophe is but a special case of the general problem of death. In a world where, let us say, 30 million people die annually of disease, accident, or physical exhaustion, the fact that 100,000 died in such con-

tiguity as at Messina is indeed appalling, but in itself, apart from the mere fact of numbers, not more so than the sudden death of any intimate friend. Each one of these men and women died, could die only once: there was no violation of the order of Nature, and an innocent saint who happens unwittingly to stand athwart the forces of Nature will suffer, yet not in his soul. But the righteous perished with the unrighteous! Even if the naïve assumption that such a calamity was a judgment upon sin were defensible, the profounder fact would remain that the infinite shame and punishment of the wicked just is that they involve the righteous and innocent along with them. By slow degrees man wins the truths that set him free at once from the torment of mental fears and the tyranny of natural forces: this is the story of his evolution. Yet even in the highest civilisation and under the most beneficent political régime he may live a captive in the prison of his fears, if so be he has no sense of his immortability. But in the mind that realises that God hath set eternity in the heart of man, that human life is but a stage in a long process of growth, that in reaction with the assertive forces of Nature man has come to be what he is, so that out of disaster has often come individual and racial salvation alike,—in such a mind there is a certainty of good that the fires cannot quench nor the shakings of the earth remove.

But Evolution is something more: it is continuous, orderly, and broadly progressive change, from the simple to the more complex. To say "broadly progressive" is simply to read the facts. At the same time it should be clearly understood that Evolution and progress are not synonymous, convertible terms. Evolution is not an innate tendency towards progression.

There is no single law of progress in Nature, nor is progress in any group a necessity regardless of conditions. Degeneration may be there, or, it may be, through many a generation the type persists unchanged. The laws of Evolution have in themselves no necessary principle of progress. Their functions each and all may be defined as cosmic order. Evolution is continuous orderly change, but it is only when we regard the stream of life as a whole without fixing our attention on the pool-like tracts and the contrary surface currents that the general progress is appreciable.

Inspection of the geological record discloses the fact that the different eras have been dominated by some one class in particular, and that with the advance of the ages the members of these ruling dynasties have belonged to successively higher orders in the animal scale. Mollusc, fish, reptile, and mammal, roughly characteristic of the Pre-Silurian, Silurian, Secondary, and Tertiary eras, each had its day of power and then fell before the fitter successor. Yet though they lost the sceptre they did not utterly perish, but proceeded to occupy a humbler station. The organic kingdom has ever risen in its highest forms, and become more and more complex not merely in constitution, but in range of commerce and adaptation to the environment. There is evidence of a rhythmical movement in which creation, both in classes and types, is carried onwards in successively higher forms that bear definite relations to preceding forms.

Finally, Evolution is a process of continuous, orderly and broadly progressive change from the simple to the more complex, which arises as the resultant of several factors operating from within and from without. Of these the best understood are the following: Heredity

in virtue of which like tends to produce like, Variation resulting in the differentiation of types, Environment, Natural Selection and Sexual Selection, Isolation physiological and geographical, Altruism, and what for lack of better language may be termed the Directive factor.

For our ultimate theory, whatever it be, must be one that will cover the whole range of experience down to the last detail. And while Nature appears as a realm whose operations are everywhere orderly, and capable, so far as they are understood, of being expressed in the shorthand formulæ that are familiar as her laws, yet is it just as certain that we find her capable of modification not merely by the human will realising itself in and through these laws, but we also become aware of other modifications on a larger scale (*e.g.* the formation of the Carboniferous flora, the efficiency of the Ice Age in the formation of soil seen in the transporting of great rock masses, the increased grinding of surfaces to gravel and clay, and the intensified action of expanding river systems), whose postponed as well as immediate utility tend to suggest that they find their origin in the Divine Reason. At any rate such a conception would appear to be more true to the totality of fact than that mechanical view alien to thought and purpose whose sole function seems to be the maintenance of the sum of the kinetic and potential energy in the universe as a constant quantity.

It is here, then, that we find the dividing line between interpretations of Evolution that are merely mechanical and those that find in it spiritual significance. The data are, of course, unaffected, whatever be the theory of them: they are always there. Any change in our theory about the data will not affect the data; it may

affect ourselves. It is only by a thorough examination not merely of the process but of each of its several factors that we find their insufficiency to account for that in which they play a part.

With regard to the factors it is in no way difficult to show that those of the forces composing them which are immediately the expression of purely physical conditions are a comparatively insignificant part of the whole. Spirit is there and at work: when it is denied in the broad sense of the religious evolutionist, it is introduced not merely into the particular unit like the cell but even into the atom by the hard-pressed Haeckelian. The law of the Conservation of Energy *e.g.* says nothing as to when—quite apart from conditions—one form of energy is changed into some equivalent quantity of another, or into which it is so transferred: that depends upon many qualitative factors. However expounded, the mechanical solution, while it (and here only partially) succeeds in setting forth the series of changes that are the most obvious components of the process, yet fails in any explanation of the concurrent changes in the progressive whole. The mechanical theory tells us truly that given *a*, *b* will follow as an effect; but it does not tell us why *a* is given; we are left in ignorance why *b* and not *c* is the resulting effect: or if answer is given it is found in a barren necessitarianism out of which you get exactly what you put into it. It is this "why" that constantly reminds us that our mechanical conceptions are after all mere abstractions, that reality may be something that obeys our abstract network of law, and yet is something greater than law, greater than all our explanations of it.

Indeed, we find that as the chance element is more and more eliminated—and that is directly in propor-

tion to the advance of knowledge—the certainty of direction becomes more and more impressive. Darwin based his theory on fortuitous variations and an indefinite number of them. The modern reply is that variation is a definite thing, and inquiry is meanwhile directed into the origin of these variations. "The materials for natural selection are furnished by the *ensemble* of an enormous number of characters, each of which is a unit pursuing its independent history and fluctuating and mutating and moving in direct lines under laws which the philosophic palæontologist has proof of, but totally fails to understand. Consequently he assumes the agnostic position that there is some principle, or principles of direction, or better . . . 'unknown agencies,' still to be discovered other than the principle of order coming out of fortuity."[1] It is recognised that it is not the survival of the fit that calls for remark, as Schurman long ago pointed out. What excites our interest is the question not of their survival but of their arrival; it is the question of the origin of that fitness itself, for there is no wonder in the survival of that which is fit to survive. Now, if this arrival is in every particular definite, if evolution takes place along definite lines of growth with no break indeed, but with significant crises, then every causal force is retained in full activity as the naturalist requires, but in addition there is some explanation of the systematic character and the continuity of the results. It becomes increasingly hard to believe that that in the world which mind interprets to be kin to itself should have another origin. On any other view the irrational produces the rational.

Evolution thus spiritually conceived enables us in large measure to harmonise the natural and the super-

[1] H. F. Osborn, *Science*, N.S. vol. xxix. No. 753, p. 896.

natural, between which there is substantial unity in spite of their diversity. It relieves us from all embarrassment of a time element. It places us in the midst of the creative movement and compels us to think of God as actively determining rather than as having determined events. In a way that was never possible it shows us what it is to be fellow-workers with God, and suggests that as in conversation with our friends and observation of their activities we come to know their mind and intents, so in communion with God, and in investigation and reflection upon His processes, we may so learn His Will for us and for the world as to put our lives efficiently into line with the eternal purposes. "My Father worketh hitherto"—that eternal work receives a new content; "and I work," and so must we. That for which the spirit of man has longed—that which he found in the miracle—the evidence of a spiritual process in the world ready to exert itself in behalf of a divine order—is for ever secured in the evolutionary conception of the divine immanence. It is almost needless to remark that thus to conceive of Evolution involves no change in our ideas of the love and power of God; these ever abide. All that we have attained is a more orderly conception of the method of the divine working, a method that explains the whole process, showing Him abundantly immanent in a world that is yet in Him. God becomes known to us in certain of His attributes as an ever growing revelation: He is on record no longer the fixed formula of the schoolmen, in experience not even the perfected presence of the Pietists.[1] For truth itself as we know it is gradually found to be no longer the absolutely immutable thing that we conceived it to be. The data of to-day are modified and subsumed in the

[1] Cf. J. Bascom, *op. cit.* p. 183.

more comprehensive data of the morrow. Incessantly the mind pushes on, and the truth gained at any point is an indication of the direction taken by the Supreme Reason, a hint of a foundation line, rather than any absolute final product.

Evolution thus conceived is not a creed, nor a new religion, nor a body of doctrine to be believed without being understood. Dr. Woods Hutchison has indeed entitled a book *The Gospel according to Darwin*, but I am unaware of any saving grace in Evolution, unless that it saves a man from pessimism. If he is inclined to despair of the progress of the race let him but turn and see the road by which it has come, or look unto the rock whence it was hewn and to the hole of the pit whence it was digged. Evolution does not explain the origin of life, although it helps us to understand the origin of the different kinds of life.

CHAPTER VI

NATURAL SELECTION

WHEN we speak of the proofs of Evolution, we do not mean anything in the nature of an Euclidean demonstration: such proof does not exist. Nor is there in strict speech any unequivocal objective demonstration of the doctrine of descent. The whole argumentation is strangely subjective. The evolutionist believes in descent not so much on irresistible isolated objective data, as on logical induction from curiously scattered, always incomplete, lines of evidence. Yet in every case the hypothesis of descent covers the facts, and nothing is known that is in vital conflict with it.

For those who have lived all their days in an age whose Open Sesame has been "Evolution," it is not easy to realise the tremendous revolution in thought that followed the publication of Darwin's work entitled *On the Origin of Species by means of Natural Selection and the Preservation of Favoured Races in the Struggle for Life* (1859). The modern difficulty indeed is to understand how it was ever possible to entertain any other ideas about the origin of species than those that obtain to-day. The real change, however, has taken place in connection with our ideas of what a species is: here rather than in ideas about their origin lies the chief difference between pre- and post-Darwinian thought. It is a fair question whether after all Darwin

told us anything that is absolute about the origin of species, but he did show us that there was nothing in creation that corresponded to the older naturalists' idea of a species. And once that old conception was dissipated, the correlated ideas about the origin, relations, and fate of species naturally went into the melting-pot as well.

The pre-Darwinian unit of classification was the species. It was selected because the fluid character of the included varieties was known, while the relationship of the more comprehensive groups (genera, families, orders, etc.) was distant and in great part unknown; again, species seemed to correspond to the various "kinds" after which it was believed the Creation Narrative affirmed the Creator to have fashioned the world of life. Further, varieties were cross fertile; with species was introduced cross-sterility—the divine barrier set for the preservation of organic order. Species were accordingly immutable, and speculation concerning their transmutability was as vain as the meditations of an obsolete alchemy upon the possible transmutation of metals. Such was the static view of the organic realm which dissolved under the play of the Darwinian searchlight into a dynamic representation of living forms. Yet many proofs of organic evolution are more correctly regarded as disproofs of the old conception of a species

The details of such proofs and disproofs may be gathered in numbers of appropriate text-books. They arise out of considerations that are physiological in character, dealing with the functioning and nature of living forms. To these may be added morphological data dealing with the structure of forms, historical arguments drawn from the racial and individual history, and finally geographical indications, based on the terrestrial distribution of plants and animals. In

illustration of a physiological disproof of the older view, reference may be made to the modern position regarding the cross-sterility of species and the cross-fertility of varieties. It consists in the direct and successful challenge of the older view. The evolutionist may admit that he knows as yet no case where domestic varieties are sterile when crossed. The reason is that fertility has usually been definitely selected as a characteristic by breeders, and it is most probable that if they deliberately set to work to produce infertility between varieties they could achieve it. On the other hand, the evolutionist can unhesitatingly assert that true species, natural and domesticated, are not always sterile when crossed, not indeed in rare examples, but on such a scale as to suggest that the old criterion of cross-sterility is practically worthless. It has in short been demonstrated, not indeed that all species are mutable, but that they are not all immutable, until the realisation has grown of how hardly we may reach a justifiable conception of a species. The modern conception seems vague and indefinite compared with the clean-cut pre-Darwinian view; indeed, a leading Neo-Darwinian has proposed that the term should be dropped altogether as corresponding to nothing in fact.[1] A species is simply a group of organic forms that are more like one another than they are like anything else, that ordinarily interbreed, and that might be thought of as having a near community of ancestry. It is, however, the individuals that are real, rather than the species; the latter is but a relative conception embracing a number of forms that show certain well-marked characters with a noticeable though not absolute consistency from one generation to another. This does

[1] Sir E. Ray Lankester; see Prof. E. B. Poulton, *Essays on Evolution*, p. 62.

not mean that there are no differences between species and varieties. As a general rule the former show much greater structural differences than the latter and are in a marked degree more stable; none the less it is impossible to draw any hard and fast line between them. Alike amongst living and fossil forms species are usually distinct and without intermediate links, but on the other hand there are classes, *e.g.* Foraminifera and Sponges, where the conception is practically valueless, so minute are the gradations between the various groups. Hence we have come to think of a species not as a sharply delineated group of living forms, but as an "abstract central point around which a group of variations oscillate";[1] where we see the peripheral oscillations of one species overlapping those of an allied species we are tempted to look for transmutation.

Of the other proofs, that one which deals with the individual aspect of organic history offers perhaps the most striking contributions to the elucidation of the problem. It is to the effect that every animal briefly rehearses scenes out of the story of its ancestral history on the stage of its individual history,—"climbs its own genealogical tree," as Milnes Marshall picturesquely phrased it. If it be the case that throughout organic history the progeny of any individual has never commenced life at that stage where the parent form left off, and that its own history represents either a slight advance on the parental history or a failure to attain that stage, then the Recapitulation Theory simply must be true in some form. More strictly it implies that individuals of the higher forms of life pass in the course of their embryonic development through temporary stages which resemble the embryonic conditions of

[1] P. Chalmers Mitchell, art. "Evolution," *Encyc. Brit.*, 11th edit., vol. x. p. 35.

some of the lower (*i.e.* older) forms in the line of descent. The proofs are very striking, and even include stages that are comparable with the adult form of certain types that lie in the line of evolution, but this is naturally true only of the earlier stages. The recapitulation is never precise; it is in no sense a detailed rehearsal. Stages are often skipped and short cuts discovered; other forms show obscuring characters that are secondary adaptations to modes of life of which their ancestors had probably no experience. Nevertheless, in this suggested theory of these resemblances we have an historical interpretation of great value that is applicable in the case of mental and moral characters with as surprising results as in the case of those that are purely physical.

The Basis of Natural Selection.

Of those factors whose resultant is Evolution it is convenient to mention in the first place Natural Selection, the distinctively Darwinian factor, whose value has been emphasised by Neo-Darwinians in a manner that quite out-Darwins Darwin. The idea was suggested both to Charles Darwin and A. R. Wallace by the study of Malthus' *Essay on the Principle of Population* (1798) in which as the result of inquiries into what actually took place in certain districts of America that amiable clergyman maintained that while the population increased in a geometrical ratio, the increase of food supply was only on an arithmetical ratio, a condition of things which would in a limited world eventually result in a struggle for existence. Transferred to the plant and animal kingdoms, the idea developed into the distinctive Darwinian assertions: 1, (fact) that by reproduction the number of individuals tends to increase in a geometrical pro-

gression; and as the food and place for these are limited, (inference) there necessarily follows a struggle for existence: 2, (fact) the offspring usually exceed the parents in number—in the majority of instances to an enormous degree—and yet there is no increase evident in the total sum of living organisms; (inference) accordingly, on the average as many plants and animals die every year as are born; 3, (fact) further, the offspring whether of one or two parents or of a generation all differ from one another in varying degree of form or function, and (inference) in this struggle for existence those individuals whose variations are of such a nature as to give them some advantage over their neighbours will survive, and, leaving offspring, transmit to the next generation the advantageous characters that had survival value. This continual transmission of fortunate genetic variations results at once in modification of species and in that marvellous internal and external adaptation that constitutes so much of the wonder of Nature. The phrase Natural Selection as descriptive of the process is, however, incomplete and to that extent misleading. It is incomplete in so far as it expresses only one half of the truth. Natural Selection might just as well be called Natural Rejection: Darwin's phrase emphasises only the positive affirmative aspect of the process. The other aspect, the destruction of the unfit, is possibly the broader and in that degree the more important. It is in this sense that the word selection is especially misleading. Strictly, as H. W. Conn insists,[1] there is no selecting, no selector. Nature does not so much select the best, as eliminate the worst.

Of the enormous increase of organisms in geometrical ratio, many interesting statistics have been collected.

[1] *The Method of Evolution*, p. 70.

Taking one general example and assenting to the reasonable proposition that there are one hundred trillion flies in the world to-day, we would find that, could they all be destroyed instantaneously, yet in three months one pair would have produced as many. Should each fly have the most favourable environment, no one could escape the plague of flies; no miracle would be so simple, only it would not be miraculous. Yet we do not notice any marked increase in flies or any of the myriad forms of life, about which the same statements could be proportionately hazarded. Intra-specifically as in the case of the members of an ant community, inter-specifically as in the feudatory relations of carnivore and herbivore, as also with the various forces of inorganic Nature, each individual wages a threefold warfare, not necessarily continuous,[1] yet of sufficient severity, particularly in the early stages of the individual life,[2] to maintain the species at an average strength. Under this pressure any slight modification in structure or function that gives an advantage to an individual may ensure its survival; on the other hand, in many cases no degree of modification whatever will avail for the survival of the harassed species. There is no absolute rigidity of action under Natural Selection, yet on the whole as the result of the struggle for existence it is the fitter organisms that win, in the biological implication of surviving to leave offspring. That the powers of reproduction seem to exceed the need of the species is simply due to the fact that it is this very prodigality of life alone that has made

[1] It is also further lessened by the divergence of species into unoccupied localities, where the pressure is consequently not so severe.

[2] With certain modifications, these statements hold also for the human species. About 48 per cent. of the population of England die before the age of 25.

evolution possible. It ensures that competition without which there could be no differentiation and so no advance. Forms that did not develop this power of excessive reproduction must speedily have been outdistanced by forms advancing by selection, and were eventually exterminated. Of the sole sufficiency of Natural Selection in the mechanisation of Evolution a large and important school is fully convinced. Yet it can act only on prepared material, so to speak, and after a certain point: it is entirely dependent on a supply of variations with whose origin it has nothing to do except in so far as it may be said to determine which individuals—the media of variations—shall give rise to other individuals. More particularly its insufficiency has been urged in such connections as accounting for the formation of paired organs and incipient new organs, or indifferent and seemingly useless specific characters of form,[1] size, and colour, as also in explanation of complete degeneration, or the appearance at the right time of those many variations that comprise specifications of qualitative and co-adaptive character. There is no question that the fact of mutation and the principle of correlation help considerably in lightening the burden that Natural Selection is made to carry. On the other hand nothing is more remarkable than the way in which Darwin, while holding as long as possible to Natural Selection, yet finally turned to the Lamarckian factors[2] to help him round a difficult corner,[3] or the candour with which he admitted that serious difficulties stood in the way of Natural Selection. Thus his theory of Pangenesis was a distinct attempt to formulate a possible basis for

[1] Cf. Arthur Dendy, *Outlines of Evolutionary Biology*, p. 421.

[2] The principle of use and disuse, and the direct action of the environment.

[3] *Origin of Species* (new impression), pp. 656, 657.

the inherited effects of use and disuse. He saw clearly that degeneration or complete reduction in an organ or parts could not be explained by Natural Selection. Weismann sees this also, but provides an epicycle in his theory of Panmixia, which simply means that when an organ or quality is developed by Natural Selection, then that agency is necessary for the maintenance of the specific condition. If Natural Selection ceases to act, in the resulting promiscuous breeding the quality is no longer selected and gradually drops out of sight amidst the countless other competing variations. Weismann himself has, however, admitted the practical impossibility of explaining complete effacement in this way, and enunciated a further theory of Germinal Selection, —which is also a confession of the failure of Natural Selection to offer any account of the coincident appearances of necessary variations in many forms. It is an attempted explanation of control, as it were, of the origin of fit variations. But even here it is not difficult to multiply objections, and, in any case, Germinal Selection is pure hypothesis. In fact, Darwinism is as Ptolemaicism and needs the introduction of subsidiary cycles and epicycles to make the explanation cover all the facts. Which simply means that it is incomplete, if not positively faulty: the Copernicus of Biology has not yet arisen.

Ethical Aspects of the Struggle for Existence.

In many minds there is associated with the term "struggle for existence" a grim, relentless, cruel combat waged by man and beast alike although in different ways, from which death alone grants a merciful release. So far as the term is applied to human campaigns against zymotic disease, alcoholism, or even to war itself, it is a legitimate application of the biological

idea. On the other hand, to use the term in connection with the modern struggle towards a higher plane of existence, material or social, is, as Conn points out,[1] simply a misapplication. For the idea which lies at the basis of Natural Selection as a factor in Evolution is that of a struggle in which the unsuccessful are actually eliminated and so fail to reproduce their kind. Now, amongst civilised races, except under rare conditions, the struggle for food is seldom such as to affect his reproductive efficiency; still less does it involve elimination. Indeed, it is rather a matter of regret to modern masters of eugenics that our humblest classes, presumably those most near starvation-point, are so prolific. The struggle in the case of man is severe enough without having the conditions obscured by secondary and comparatively unimportant applications; yet that conflict is waged with hopefulness as man by his intelligence progressively turns the edge of Natural Selection.

In the case of the lower creation the impression is not so immediately hopeful. Poet and man of science alike have indicted Nature, and the charge of cruelty and unmorality seems to cut deep.

> "The Mayfly is torn by the swallow, the sparrow spear'd by the shrike,
> And the whole little wood where I sit is a world of plunder and prey."[2]

Huxley also permitted himself to write of "the myriads of generations of herbivorous animals" which have lived "during the millions of years of the earth's duration . . . and have all that time been tormented and devoured by carnivores"; of carnivores and herbivores alike "subject to all the miseries incidental to old age, disease, and over-multiplication"; and of

[1] *Op. cit.* p. 57 *et seq.*

[2] Lord Tennyson's *Maud*, Part I.

"the more or less enduring suffering which is the meed of both vanquished and victor." And he concluded that, since thousands of times a minute, were our ears sharp enough, we should hear sighs and groans of pain like those that Dante heard by the gate of Hell, the world cannot be administered by what we understand as benevolence.[1]

The difficulty in reaching a correct estimate of the conditions of Nature is increased by the rise of a recent literature[2] which would have us believe that many wild animals lead lives on planes of intelligence and happiness scarcely attained by humanity. The truth as usual is probably somewhere between, and larger than the pessimist's or optimist's purview; the one is as dangerous an individual as the other. To pronounce satisfactorily upon the ethical aspect of the struggle for existence it would be necessary to know all the facts, or at least to try and do so, as also to guard against anthropomorphism when studying the face of Nature. Into any such judgment four distinct, unrelated, and in some degree paradoxical, considerations would need to enter.

I. The comparative study of the nervous system in the animal kingdom seems to show a varying capacity for pain which in the highest animals even is very different from the capacity in savage man: and as we descend the animal scale, the capacity lessens. What is pain in terms of physiology? It is the peculiar sensation experienced by the brain as a result of injury to or affections of the sensory portion of the nervous system. Hence, if the sensation of pain is ultimately referable to the brain, it seems a fair infer-

[1] *Evolution and Ethics and other Essays*, pp. 198, 200.

[2] *e.g.* Ernest Seton Thompson's *Wild Animals I have known*; Jack London's *The Call of the Wild.*

ence that the intensity of the sensation—the capacity for it—will be dependent on the degree of organisation of that organ and of the nervous system associated with it.

It is not proposed to make any detailed comparative examination of the nervous system, but rather to state a few facts which will serve to indicate the strength as also the limitations of this particular consideration. If we commence with the Protozoa, we find in their case a diffuse sensitiveness to external influences, but in the total absence of anything corresponding to a nervous system we cannot suppose for a moment that they feel pain. So far as any accurate account is given, the nervous system of the great group of Cœlenterata, apart from certain sense organs, is entirely motor; the effects produced are on a par with those resulting from the flicking of a mimosa leaf. There are no sensory nerves to conduct the sensation of pain, no brain to become aware of it. In fact, detailed investigation of the invertebrate kingdom would show that pain as human beings are sensible of it must be absolutely unknown there. Says one competent observer, "When a crab will calmly continue its meal upon a smaller crab, while being itself leisurely devoured by a larger and stronger; when a lobster will voluntarily and spontaneously divest itself of its great claws if a heavy gun be fired over the water in which it is lying; when a dragon-fly will devour fly after fly, immediately after its abdomen has been torn from the rest of its body, and a wasp sip syrup with evident zest while labouring—I will not say suffering—under a similar mutilation: it is quite clear that pain, at any rate among the crustaceans and the insects, must practically be almost or altogether unknown."[1]

[1] Rev. Theodore Wood, F.E.S., art. "The Apparent Cruelty of Nature," *Journal of Transactions of the Victoria Institute*, vol. xxv. p. 257.

When we reach Vertebrates we at once begin to get into difficulties, interpreting *e.g.* the wriggling of the landed trout as writhing, and tending to forget the accumulated evidence that serves to indicate that even severe laceration in the region of the mouth causes fish little inconvenience. Amongst reptiles, especially lizards, the instinct of self-mutilation in the caudal region is not uncommon, betokening a low grade of nervous development, and birds with their horny beaks, their scaly legs and feathered bodies are at any rate not so exposed to the possibility of pain through contact as creatures more and less highly organised than they are. To this there probably corresponds a low pain-susceptibility.

When we reach the great class of the Mammals, the question presents itself to us in another form, and we find ourselves looking for some standard by which we can compare their sensitivity and ours. What we want to know is whether we are justified in imagining in the case of a creature showing what seems to us undoubted signs of suffering that the pain it endures is comparable to that which human beings would feel under similar circumstances. If we confine ourselves for the moment to the human species we find considerations that largely answer the whole question for us. For we have only to think a moment to realise that the pain consequent on the same injury to two men is by no means equal in intensity. This is strictly true of physical injury, but it also holds of moral suffering, and if this fact were realised our whole penal system would be altered. In the human subject the capacity for appreciating pain is to a marked extent a matter of temperament as also of civilisation. Everyone has gathered from his general reading that pain to the savage and pain to the civilised man are

two quite different things. One may, *e.g.*, refer to the rites by which the young "braves" of various Indian tribes were initiated into the full privileges of manhood, or to the story of Livingstone's bearer with the broken thigh. As the result of large experience in operative work, Dr. Felkin calculated that the relative susceptibility to pain in the European, the Arab, and Negro is in the proportion of three, two, and one. He also noticed that in the case of the negroes the result of education was to increase their susceptibility to pain by one-third.[1] We can see this same thing ourselves any day. We know that an injury that would prostrate a brain-worker would be received with comparative indifference by a hand-labourer. Education is higher-grade civilisation. It results in brain development, and this reacts upon the whole nervous system, inducing a far greater susceptibility to pain than would otherwise have been the case. As a general rule, highly educated men and women are the most susceptible to bodily suffering. By study and culture of the mind they gain a great accession of intellectual power; but with this is developed *pari passu* increased sensitiveness of nervous organisation. It is the price paid for a brain. That is to say, susceptibility to pain reaches a maximum in the case of those who have the greatest capacity of mental power: the power to do and to enjoy varies directly as the power to suffer. They are all indices of high development.

In relation to the alleged cruelty of the struggle many additional data have been collected tending to show that insensibility to pain attends the most characteristic methods of feral warfare and execution. Soldiers in battle have often been unaware of serious

[1] Quoted by Rev. Theodore Wood, *op. cit.* p. 263.

wounds until weakened by loss of blood, and the temporarily benumbing quality of the feline blow has been attested again and again. The wild beast looks not before or after in contemplation of impending doom: its life is entirely in the present. There is nothing save sympathetic misinterpretation to suggest that animals live lives of continual alarm and maddened endeavour to escape the death that is never far from them and inevitable at last. It is impossible to believe that any species could have thriven in its surroundings —could have survived as fittest and left offspring—if such had been the actual conscious conditions of their life. Would life be worth living—could it be lived, if *e.g.* sparrows were in constant fear of the sparrow-hawk? We see their seemingly terrified attitude on the approach of the racial enemy, but no more is involved in their instinctive response to the signs of danger than in the shutting of our eyelids to protect the eye. The sparrow does not think: a danger past is an incident done with. Amongst the elements that have gone to compose survival-fitness there has been included an automatic response to specific signs of danger; as also an increasing capacity for suffering, which therefore on the Darwinian hypothesis if not good, must be at any rate useful. Nor is it easy to see how the pain or misery that is presumably the meed of the unfit or disappearing race can actually affect the individual comfort. We have never been asked to suppose that the lives of individuals in a disappearing race, *e.g.* Red Indians, are on that account less pleasurable than the lives of individuals in an increasing race. What we observe is an excess of deaths over births in the long run, owing to particular circumstances, not necessarily pain-inflicting,—an unconscious process of extinction.

In an extremely interesting study[1] E. K. Robinson has attempted to get at the root of our misinterpretation of animal life, and raises the question whether there is not a difference between mental consciousness and bodily sensation. He quotes with effect certain lines from "That Day," in which Rudyard Kipling describes one of those sudden panics into which even the British soldier may fall:

> "Till I 'eard a beggar squealin' out for quarter as 'e ran,
> An' I thought I knew the voice an'—it was me!"

Here is graphically pictured the momentary dislocation, as it were, of the purely animal unconscious instinct and the governing and controlling consciousness in the fugitive soldier, and the suggestion offered is that all the experiences of the lower creation are of the former type. If the soldier had been speared through the heart before he realised that it was his own voice which he heard, he would have died without consciousness of the anguish of fear. "I didn't know what I was doing," we sometimes say of moments of crisis when we act instinctively. So do the lower animals live and die a mesmerised kind of a life, all unconscious of bodily agony that they may be suffering. That is to say, although to all appearance animals may be suffering pain, yet it does not necessarily follow that they do so consciously. Or in Robinson's most extreme statement[2]—"We all think in words: and there are no ready-made words in which we can think of animals feeling pain without being conscious of it." The animal continually acts, as we sometimes do, "on the spur of the moment," but does not appear to reflect subsequently upon such

[1] *The Religion of Nature.* [2] *Op. cit.* p. 16.

action. The sheep in the park rushes in evident headlong terror from the dog, but when the latter is called off, immediately it puts down its head and quietly resumes feeding. The animal "acts before it thinks," only it does not think. Man usually thinks before he acts, yet occasionally he instinctively reverses the order. He chooses his line of conduct. Nature has chosen it for the lower creation by the elimination of all courses save the right one. Accordingly we imagine that the animals have chosen because they do what often seems to us right, and most often very wonderful. What we really see perhaps is evidence of something kin to our own minds in the external direction of their lives.

II. Examination of the conditions of organic progress shows that it has always been the outcome of a certain saving discontent. Progress follows acute organic dissatisfaction. It is the result of constant experimentation in the individual life. Nothing in this world of things organic or inorganic is perfect, although much is becoming perfect. The adaptation to environment is never perfect in any case. Perfect physical conformity, complete adaptation would mean eventual death. As the conditions change it is necessary that there be change in the adaptation,—that way alone survival lies,—but perfect adaptation would involve complete surrender to a definite environmental phase, and such extreme specialisation carries with it exhaustion of adaptability. Probably the nearest approach to perfect adaptation is to be found in the case of some parasites; but that means eventually degeneration, stagnation, death. If we consider any period of organic history we shall find that its dominant forms, so far as freedom from danger and discomfort is concerned, were forms ultimately

doomed to degeneration or stagnation.[1] Every progressive race has had to choose between the present and the future, and in so far as it elected the present it surrendered the future. The type that will hold the future has not completely conformed to the present: it has exercised a certain non-committal aloofness to the present. To a definite extent conformity is necessary, indeed is a condition of survival, but it is not in itself a guarantee of progress. Consider the days of molluscan glory and the almost perfect adaptation of the oyster. Protected within its shell which hindered locomotion and reduced nervous intercourse to a minimum, living in the midst of plenty and like a true worldling occasionally doing a pretty thing as it healed its hurt with a pearl, its life was for the present—a rich and easy life, reproducing its kind in legions. And in the same waters were aspiring struggling forms, ancestral to true vertebrates, feeble in size compared with Orthoceras, scantily protected as measured by Crustacean armament, and yet the day was to be theirs. Or if seated on some point of vantage in Jurassic days an observer had been asked to choose from out its rich and varied fauna the form that would survive, would he have passed over the various groups of powerful saurians and given the verdict to the little marsupial mammal diligently striving to avoid becoming a saurian meal? Its very inability to contend in brute strength may have driven it into brain-building. At every stage the same story may be read. It is not a parable: it is a transcript of all phylogeny. A long range view of organic history shows that ultimately the race has never gone to the swift nor the battle to the strong. There is no form

[1] This point and subsequent illustrations have been directly suggested by J. M. Tyler's *The Whence and the Whither of Man* (1899), p. 194 *et seq.*

that has not been in that narrow upward way towards a higher type of life that rises to the very end, but they have almost all gone out of it. "Say not the struggle nought availeth:" from the evolutionary point of view it availeth everything.

III. No account of the struggle for existence can pretend to be complete which fails to take notice of the mutual service or self-sacrifice that enter into it so objectively. The recognition of the existence of such a factor as altruism must inevitably modify our conception of the character of the evolutionary process very profoundly. Geddes and Thomson had pointed out the reasonableness of recognising in animal life "the co-existence of twin streams of egoism and altruism, which often merge for a space without losing their distinctness, and are traceable to a common origin in the simplest forms of life:"[1] and Herbert Spencer had previously stated "that without gratis benefits to offspring, and earned benefits to adults, life could not have continued. . . . By virtue of them (altruistic principles) life has gradually evolved into higher forms."[2] Prince Kropotkin also, in articles on "Mutual Aid among Animals," had drawn attention to the factor.[3] But it was Henry Drummond[4] who first gave a really detailed account of it, showing the gradual domination of the self-regarding activities based on the function of nutrition by the other-regarding activity grounded in the function of reproduction. "Sympathy, tenderness, unselfishness and the long list of virtues which make up Altruism are the direct outcome and essential accompaniment of the reproductive process. . . . For

[1] *Evolution of Sex*, p. 279.

[2] *Principles of Ethics*, vol. ii. p. 5.

[3] *Nineteenth Century*, Sept. and Nov. 1890.

[4] *Ascent of Man*, chap. vii.

a time in the life-history of every higher animal the direct, personal, gratuitous, unrewarded help of another creature is a condition of existence."[1]

Accordingly it is not suggested, nor did Drummond pretend, that he first called attention to the existence of this factor. He was not the discoverer of this "stream of altruism," but he first made a systematic exploration of it. If, in tracking the stream to its source, he sometimes fancied he found it trickling where it did not actually exist, or marked its course as open where in reality it was still flowing underground, we may pardon the errors of an enthusiastic explorer. But he did more, for he followed the stream in the opposite direction, and maintained not only that at a certain point it united with the other, but that the turbid waters of the stream of egoism were being lost in the clear flowing tide of altruism. In the chapter referred to he traces a certain altruism throughout the brute creation, and tries to show that the evolution of animal life, while not in itself necessarily moral, might still have been preparing the way for morality in man.

This altruism expresses itself in various ways. Indirectly the principle is operative in countless favourable interrelations between animal and animal or animal and plant that have as result an increase in the sum of life, as also in those different aspects of gregariousness that represent more effective ways of carrying on the struggle. More directly it is manifested in that care of the young and willingness to surrender life for them that have proved far more effective elements in racial progress than the sharpest tooth or keenest eye. Altruism has paid its way from the beginning, bounty-fed by the more abundant life

[1] *Op. cit.* p. 186.

that has followed in its wake, expansive in virtue of the very limitations it imposes. Pure selfishness, isolating and improvident, may by reason of its complete conformity to the present, acquire a temporary dominance, but it has no hold upon the future, and is its own destruction. Co-operation, then, in its various phases, in fact all the various relations and favourable interactions that organisms adopt whereby life more abundantly is produced and as a result higher life is evolved, have definitely to be recognised in any account of life, as without them it would have ceased. Self-sacrifice, conscious or unconscious, is a condition of continued life; all the specific adjustments of creatures are ultimately there for generations unborn.

Now, while reflection on this altruistic factor suggests certain correspondences with moral teaching and practice, it is not just so easy to see the higher justification of the self-regarding activities. If altruism be held to be the sum and substance of morality, this difficulty must always remain. On the other hand, may it not be urged that altruism does not exhaust morality—that self-preservation, self-assertion, self-perfection are just as important and as necessary to ethics as self-surrender, self-abnegation, self-sacrifice? In that event it is possible to find the counterpart of the natural self-regarding struggle in the higher sphere of the spirit. For self-love in its noblest sense is just as much a duty as to show love to our neighbours. Life, after all, resolves itself for us into the play—the action and interaction—between the organism and its environment, human or physical. Unless a man sees to his personal development, he will have nothing to give to others. Life is a perpetual giving and receiving: he who has nothing to give is dead; he lives most who gives the most and the best. And as a man dare not

rightly give to others that which involves moral loss or harm to himself, so for the very sake of others he is bound to make the most of himself. The altruistic motto is, "Thou shalt love thy neighbour." The individualistic motto is, "Thou shalt love thyself." The incomparable Christian motto is a choice blend of these two words, "Thou shalt love thy neighbour as thyself." Here we have law not merely rational but Divine.

That this altruistic factor is bound to exert an increasing influence would seem to be clear if only from the unsatisfactory condition of the present stage of human evolution. The causes for this condition lie in the exaggerated social inequalities, the extremely unequal distribution of property, the excessive individualism. The integration of the human race will only be brought about as it has been brought about in humbler societies or colonies by co-operation, by a determination not merely to live and let live but to live and help live, by a public opinion which will control competition till its rivalry is never other than that healthy striving without which progress cannot be. In these directions human evolution is increasingly tending, as the result of the inspiration and leading of those who have been most sensitive to the spiritual aspects of the environment.

IV. When we have estimated the real worth of the charges of cruelty against Nature, have realised the price of progress, and considered the place of altruism, we may return to ponder the fundamental place of suffering and of service in the world. For they have been there from the beginning, curiously connected, no mere capricious incident, but part of the very pattern of the web of life. In a very real sense the successful species that occupy the great geological horizons have

come out of great tribulation, "redeemed at a great price, even of a thousand species and tens of thousands of individuals, who fell short of the typical fitness and were killed out."[1] Every successful species was but a pioneer of progress, and sooner or later, "like the scouts of a great army, was caught in some physiological ambush" to its own undoing. And as Creation is an organic whole, every part is in the service of some other. The plant world is in the employ of the herbivorous section of the animal world; it does it service. But in the course of time appear the carnivorous groups, the herbivorous forms come into their employ, the altar of sacrifice is raised, and since that day its stones have never been cast down. Suffering and service are wrought into the process. Our more abundant human life is the outcome of the travail of creation's lower forms. Whatever we have in national or social or individual life that is at all worth having has been purchased with the price of blood. It is almost unnecessary to remark that the recognition of this suffering and service is no modern discovery. The suffering at any rate has been recognised from the dawn of thought, and nothing is more pathetic reading than the hopeless solutions of the problem, whether offered by Greek, Buddhist, or ancient Hebrew. To the latter suffering was punitive: even in the most tender of the Psalms man's days were conceived as passed away "in God's wrath." "Or those eighteen, upon whom the tower in Siloam fell and slew them, think ye that they were sinners above all men that dwelt in Jerusalem?"[2] asked Jesus, combating this essentially pagan view. But to-day we realise the purpose of suffering in perfecting the adjustments of

[1] W. W. Peyton, *Contemporary Review*, October 1900.

[2] Luke xiii. 4.

the lower creatures to the world around them, and in perfecting the adjustment of man, not merely to the world around him, but to that larger spiritual world that is at once within, around, and beyond him. Or if we may not yet use teleological phrasing in our interpretation, we can at least say that life is adjustment, and that sacrifice and suffering are means for perfecting the adjustments of living things to the world around them, and, as so increasing the sum of life, are a good.

And when in more mystic mood we consider this suffering and service in the light of the Crucifixion they seem to glow with an added lustre. Suffering itself is service, and vicarious suffering is its highest expression. The principle of vicarious self-sacrifice pervades creation, and is most marvellously provocative of service in others. At Calvary the Creator draws men to Him by His own submission to this one great law of sacrifice. Viewed in this light the misery and seeming waste associated with the struggle for existence are seen to be not wholly unconnected with the profoundest fact in history. What we really have is age-long unconscious sacrifice for the good of others dimly foreshadowing the one great oblation. There is a very real sense in which the survival of the fit is the survival of the obedient. The forms of life that have survived are those that adapted themselves to the demands of the environment, and progress has consisted in completer adaptation, increased specialisation, more perfect obedience. He was obedient unto death, even the death of the Cross: therefore He lives. And so the darkest features of human suffering may undergo a strange illumination, and cease to seem the cruel, meaningless episodes that too easily they might become. The outer man is continually being sacrificed,

but in the interests of the man within, or of other men without, or even, it may be, of the world beyond. The Crucifixion has taught us once for all that there is a service of love in suffering and tribulation, that out of death there springs life.

CHAPTER VII

VARIATION

At the foundation of the Darwinian explanation of Evolution is the belief in the existence of fortuitous variations occurring in every direction in every part of every organism, and continuous in the sense that all the gradations may be found between any two extremes. The members of a species, though resembling one another more closely than they do all other creatures, are yet not absolutely alike. No two oak trees are exactly alike: no two leaves on any tree are identical. The members of species show differences that make themselves apparent even in the offspring of the same parents. It is the inexperienced eye which considers all sheep alike: far different is the shepherd's account. The trained observer can notice measurable differences in the Protozoa produced by fission, or in the numerous broods of parthenogenetic forms like Daphnia. It is these small though universal fluctuating differences that are referred to by the general name of variation, or better, variability, and to variability on the Darwinian theory is due the great diversity in the organic kingdom throughout all time. Without it there could have been no change for better or worse, neither ascent nor descent, neither evolutionary progress nor degeneration. If offspring had always resembled their progenitors, each generation would have been the facsimile of the

last, and a man and his grandfather would not have represented such extreme terms of a series as they do under present conditions. If all this is true, it is only by a study of variability that we may hope to understand the method of Evolution. Variations are the material furnished to Natural Selection: some of them as advantageous are preserved, for the essence of the principle of the survival of the fittest is utility. The happy possessors become the parents of the next generation; the fortunate character is transmitted and tends to be intensified.

Although there are no absolute distinctions, variations can be usefully grouped according to the character of their source and origin, or according as they show quantitative or qualitative change. From the former point of view we may distinguish first, those inborn variations that apparently have no relation to external conditions: they are inherent in the constitution of the individual, and inherited by it. In origin they are abintral: they develop under the stimulus of nutriment. We shall refer to them as genetic variations. There are also those changes, more or less adaptive, that are caused by the direct action of external conditions, that are the result of use and disuse, or arise as the effect of something environmental—climate, injury, or the like. They are incidental and abextral on the whole, being developed under the stimulus *e.g.* of use or injury, and constitute the so-called acquired characters. According to Weismann's views the latter are not transmitted. The term "acquired character" is, however, somewhat misleading. It expresses no absolute distinction. All characters, even those that are genetic, must have been acquired at some time or another: in the case of the unicellular form the distinction reaches the vanishing point. We shall there-

fore speak of them as modifications. From another point of view variations may be regarded as continuous or discontinuous, quantitative or qualitative. The former group will include that type of small fluctuating variation of which any gradation between two extremes will ordinarily be found if only a sufficient number of cases is sought and examined. The discontinuous variation on the other hand is sharply marked off from the other members of the group, and differs so markedly that the change may be described in most cases as qualitative.

In regard to the quantitative fluctuating variations, recent advance has largely consisted in their statistical study, for it was an early Darwinian difficulty how such minute fluctuations occurring admittedly sometimes in but a few cases, perhaps in one, could involve a utility that determined life or death, or, if they did, could avoid being swamped by cross-breeding with the parent stock. As a result it has been found that slight fluctuating continuous variations are abundant, and may affect any part or any character—even the habits—of an organism. They occur in domesticated forms and are probably equally developed in feral life. Occasionally they attain considerable magnitude, sometimes as much as 25 per cent. with gradations. Further, they are all capable of being grouped about a mean; but while in some cases the most frequent measurement or condition (technically called the mode) may be found to correspond to the mean[1] or average value for the character, in most cases it is found that under changing conditions there is not a marked grouping of individuals on the mean. On the contrary, they rather tend to

[1] Take *e.g.* four men with heights of 70, 72, 72, 74 : the mode is 72 and corresponds to the mean. But take four men with heights of 68, 70, 70, 76 : the mode here is 70, but the mean is 71.

heap up on one side or the other of the mean, with the result that, very roughly, half of the individuals are above the mean and half below it in respect of any definite character. Often the disproportion between the two groups is more marked, and the curve of their distribution may even show two widely separated modes (dimorphism), but in any case one or other of these groups will ordinarily possess the advantageous quality and will survive. That is to say, the facts of variation as they are known amongst animals seem to indicate advance upon the principle of averages rather than by any selection of individual variations however useful. Only such continuous variations as simultaneously occur in many individuals could therefore have much influence upon the race. The variation need not be obtrusively useful in order that it shall come within the reach of Natural Selection, if only it be such as can vary around a mean, and ultimately be correlated with some more important character or favourably influence the production of offspring. Small fluctuating variations could be used to give increase in any definite direction within certain limits, if the struggle for existence is keen enough to make that amount of variation of selective value, and that direction will be linear only.

A theoretical illustration may serve to make this principle of variation clearer.[1] Suppose, for example, that owing to the deeper burrowing in trees of insect larvæ it becomes advantageous to a race of woodpeckers to have a more elongated tongue. It is probable that any single variation producing a long tongue would have little or no influence upon the species. But the statistical study of fluctuating variations tends to suggest that most of the birds of a species have tongues

[1] Cf. H. W. Conn, *The Method of Evolution*, p. 111.

either longer or shorter than the average. If three-fifths of the birds must perish during some period of famine, it is clear that the two-fifths that succeed in living will be sure to contain more long-tongued birds than short-tongued ones. Now, these birds will mate with one another, and thus there would be no opportunity for the new character of longer tongues to be swamped by cross-breeding. In short, it has definitely been found that normal variations present many simultaneous variations in the same direction. As a result the next generation will have a tongue whose average length is longer than the average of the last generation. Evolution thus acts upon average groups rather than upon individual variations: "advance is an advance of a species *en masse* and not by isolated spurts."[1] Individual variations count for little: variations above or below a mean count for much. Such an advance by general averages will eventually reach a state of equilibrium. The tongue of the bird will not continue to lengthen indefinitely, because a point will be reached beyond which any increase in length would be disadvantageous. With the lengthened tongue there presumably may be correlated a corresponding lengthening of the beak, and under normal conditions a certain average character of the organs will be maintained. Should the conditions undergo change, another average length might be better fitted for the struggle, and under Natural Selection variations in that direction would evolve the new mean.

The above instance is theoretical, but sometimes it is possible to check such theory by observations in Nature. Such a chance had Professor H. C. Bumpus in the case of the (introduced) English sparrow (*Passer domesticus*).[2]

[1] Conn, *op. cit.* p. 112.

[2] *Biological Lectures*, Wood's Holl, 1898, p. 211.

One hundred and thirty-six of these were collected in a state of exhaustion after "an uncommonly severe storm of snow, rain, and sleet" in North America (Feb. 1, 1898): seventy-two revived, the remainder perished. Bumpus made a series of careful comparisons between the survivors and their less fortunate kin and noted very appreciable morphological differences. It is not improbable that the more important causes of survival or the reverse were physiological rather than morphological, but we may consider the results attained. Without going into the actual figures, it may be stated that while the average characters differed but little (and the characters investigated were total length, alar length, weight, length of beak and head, etc.), the variability of the eliminated birds about their mean was much greater than that of the survivors. The very long individuals, for example, suffered heavily in the struggle, as of the thirty males obtained in which the total length was 163 mm. and upwards, no less than twenty perished: likewise the two shortest male birds perished. Bumpus's general conclusion is that "Natural Selection is most destructive of those birds which have departed most from the ideal type, and its activity raises the general standard of excellence by favouring those birds which approach the structural ideal." Of this ideal, of course, he can give us no information, and further the number of cases observed was very small, but if all the sparrows in that region had been affected by the storm, and he could have extended the results obtained in the 136 to them all, it would probably have appeared that the next generation of birds collected in that storm-swept area would have been shorter in length, of less weight, had longer legs, wing bones and breast bone, and a greater brain capacity than their predecessors.

But, now, to realise that a certain variation appears

simultaneously in many individuals is to surrender the idea of pure fortuity and to make the variations so appearing determinate. To do this, however, is to give up Natural Selection as the basal cause of Evolution. For if variations are in this or in any measure determinate, then their direction is determined by some prior factor, and the vital factor in Evolution is not selection, but that which determines the character and the timely appearance of these variations that shall prove to have selective value. All that Natural Selection does is a sort of police work, keeping the species moving in the thoroughfare and destroying those that move out of it.

Accordingly this realisation of the fact of determinate variation—this tendency on the part of many individuals to vary simultaneously in a similar definite direction—is of great importance in the interpretation of Evolution. Some of the evidence relating to discontinuous variations is very suggestive in this connection, as we shall see. Darwin himself admitted the existence of determinate variation, but many modern biologists believe that determinate evolution is the actual species-forming factor. Continually may be found in their writings the recognition of some factor—a "directive tendency," "progressive tendencies," or "inherent influence"—at work prior to selection, determining the character and appearance of variations. In short, the evidence for trends to modification in particular directions, for this tendency of variations to group themselves and be more numerous in certain directions than in others, becomes, where it is noticeable, singularly impressive. We may not be able to understand the cause and nature of the phenomenon, but there can be little doubt of its affecting evolution. While it suggests that the direction of variation and hence of selection is pre-

determined in some way either in the nature of the living form or in its relations to the environment, it, at any rate, makes it certain that variation cannot be regarded as occurring in every direction and fortuitous. Palæontologists in particular are strongly impressed with the fact that Evolution has proceeded along definite fixed lines. They find no suggestions of "miscellaneous trials," no hints of the myriad failures that the other point of view demands. W. B. Scott in several remarkable papers has stated this view very forcibly, showing that the horse in its evolution has moved unswervingly towards a predetermined goal: the mean at any rate moves in a determinate direction. He finds it impossible to see how the definite progression in the teeth can be explained by Natural Selection: the little pin-points of difference cannot have been what determined the life or death of the species. Every stage is represented, and the evolution is direct and definite—at least it gives that appearance. He has well compared the line of this definite advance to the "track of a cyclonic storm (which) is determined by the path of the storm centre, around which the winds circulate, blowing in every direction. These circulating winds would represent the variations which occur at every stage in the history of a phylum, while the course of the storm centre would represent the phylogenetic change or mutations.[1] Thus the cycles of variation tend to repeat themselves, though the centre around which they revolve has a course of its own, dependent, not on the accumulation of these winds which happen to be blowing in the right direction, but upon factors of a much wider significance."[2]

But the origin of species has, in addition, been

[1] *i.e.* in Waagen's sense of steady advance along certain definite lines.

[2] *American Journal of Science*, vol. xlviii. p. 373.

observed from considerable variations which, as unconnected with others by gradational stages, and as involving very definite differences of sometimes considerable amplitude, are known as discontinuous variations (Bateson) or mutations (de Vries). The theoretical interest in such occurrences is great, for if substantiated they would remove another of the old weighty objections to the Darwinian account. For it has always been a difficulty to see how the first stages, say in the formation of a new organ, or even of an instinct,—the initial minute variation or expression of a character that ultimately in a more developed state was found to have survival-value,—could be of such life-and-death value as to ensure its survival: further, would it not probably be swamped by interbreeding with the common stock? A partial, though incomplete, answer was offered in the principle of correlation, and in the established fact that organs have often changed in character and function,[1] and that possibly the different stages may each have been useful for a different purpose. Now, if such characters—and this applies to instincts and habits as well—arise in a more pronounced form, in a degree sufficiently developed to give Natural Selection a handle so to speak, and are found to breed true through successive generations, this difficulty vanishes. Or, again, how by the action of Natural Selection on a series of minute and almost imperceptible variations could there arise a number of different structures or parts so co-ordinated as to share in a common function? This might occur as a mutation. As sports and monstrosities certain extreme variations have long been recognised and known. Darwin himself listed several such sports,[2] and noted that certain

[1] *e.g.* mammalian lung = swim-bladder of fish.

[2] *Animals and Plants under Domestication*, vol. i. chap. 3.

species or races at least of domesticated animals and cultivated plants had their origin in this way, as *e.g.* the now extinct long-backed ancon sheep with short crooked legs descended from a single ram-lamb born in Massachusetts 1791 with these characters, and the merino ram-lamb raised on the Mauchamp farm in 1828, remarkable for its long, smooth, straight, and silky wool. What had not been realised was the possible frequency with which such a process might occur in the state of Nature, the possibility that such sports of a less extreme character have *often* served as the initial points of new races, the possibility that, as de Vries maintains,[1] "species have not arisen through gradual selection operating for hundreds or thousands of years, but by steps (*Stufenweise*), through sudden, though quite small, transformations." "I intend," he says,[2] "to give a review of the facts obtained from plants which go to prove the assertion, that species and varieties have originated by mutation, and are, at present, not known to originate in any other way."

Darwin's variations were all linear and quantitative: and, says de Vries, in that way you can get nothing new—only increase or decrease in what is already there, dependent on the continuance of selection, but no qualitative change. This, however, is not a serious objection, for many specific characters are simply quantitative (*e.g.* smooth and hairy leaves), and many qualitative ones are ultimately quantitative. Still, Galton's Law of Regression practically shows that variations do not go on indefinitely in a linear series, but soon reach their limit—the children of parents varying from the mean tend to vary less than their parents in any particular direction,—and unless some

[1] *Die Mutationstheorie*—1901–1903, p. 150.

[2] *Species and Varieties*, p. 9.

new kind of variation arises, progress in one specific direction soon ceases. This has been confirmed *e.g.* by Johannsen, with beans and barley bred in pure lines. He notes that the tendency over a series of generations is for the average character, rather than any individual characteristics, to be reproduced. He accordingly attributes the origin of new types either to the crossing of races or species (hybridisation), or to mutations.

De Vries' account of his own work is as follows: "Complying with these conditions (requisite for sound experimental work in plant-breeding), the origin of species may be seen as easily as any other phenomenon. It is only necessary to have a plant in a mutable condition. Not all species are in such a state at present, and therefore I have begun by ascertaining which were stable and which were not. These attempts, of course, had to be made in the experimental garden, and large quantities of seed had to be procured and sown. Cultivated plants, of course, had only a small chance to exhibit new qualities, as they have been so strictly controlled during so many years. Moreover, their purity of origin is in many cases doubtful. Among the wild plants only those could be expected to reward the investigator which were of easy cultivation. For this reason I have limited myself to the trial of wild plants of Holland, and have had the good fortune to find among them at least one species in a state of mutability. It was not really a native plant, but one probably introduced from America, or at least belonging to an American genus. It was the great evening-primrose or the primrose of Lamarck. A strain of this beautiful species is growing on an abandoned field in the vicinity of Hilversum, at a short distance from Amsterdam. Here it has escaped from a park, and multiplied. In doing so it has produced, and is

still producing, quite a number of new types, some of which may be considered as retrograde varieties, while others evidently are of the nature of progressive elementary species."[1] "The main fact," he continues, about the mutating species "is, that it does not change itself gradually, but remains unaffected during all succeeding generations. It only throws off new forms, which are sharply contrasted with the parent, and which are from the very beginning as perfect and as constant, as narrowly defined, and as pure of type as might be expected of any species.

"These new species are not produced once or in single individuals, but yearly and in large numbers. The whole phenomenon conveys the idea of a close group of mutations, all belonging to one single condition of mutability. Of course this mutable state must have had a beginning, as it must some time come to an end. It is to be considered as a period within the lifetime of the species, and probably it is only a small part of it."[2] All which is an interesting combination of demonstration and speculation.

To state de Vries' facts, however, briefly: in his experimental gardens he obtained, in seven generations extending over twelve years, 834 mutations belonging to seven distinct types out of 53,500 plants of *Œnothera lamarckiana*: of these some appeared in greater quantity than others. Five of these types were observed in the original locality, but poorly developed, as also two other distinct forms, thus proving that the artificial cultivation was not the cause of the mutations. With a single exception all these types breed truly in spite of the fact that they differ from one another not merely in one but in several characters. The parent

[1] *Species and Varieties*, pp. 26, 27.
[2] *Op. cit.* pp. 28, 29.

plant holds to its specific type all through, but it may give rise again and again in this discontinuous manner to various kinds of new forms differing qualitatively from it, which may be more or less fit to survive than the parent form, and if fit, remain true to their type. Transition forms may be found, but their position is not linear, they are not necessarily intermediate steps: they may have arisen before, simultaneously with, or after, the new species. Here, then, is an origin of species very different from the Darwinian account.

The difference between the two theories is apparent. From the strictly Darwinian point of view the transformation of species is effected by the slow selection of favourable variations out of a mass of minute fortuitous fluctuations affecting usually a single character at first, later others by correlation or otherwise. This is the view shared by Wallace, and also supported by Luther Burbank's cultural work. On the de Vriesian view, species originate suddenly, independently of the Darwinian variations, by the occasional appearance in definite discontinuous form of one or several considerable variations that differentiate the new species thus originated quite markedly from the old, and these new characteristics are definitely transmitted to succeeding generations. According to the Darwinian view, Evolution proceeds by a slowly winding pathway: according to de Vries, the movement is step by step, as it were up a staircase, in a definite direction.

Two questions immediately arise in connection with the mutation theory. To what extent is it known that such mutations give rise to new species, and what are the characters of these mutations—determinate or indeterminate?

In reply to the first, the answer is that the number of known origins of species or races from such muta-

tions is disappointingly small—disappointing, that is, as in support of what de Vries claims as the method of origin of all species. In the particular case of the evening-primrose de Vries observed twelve mutations in all; MacDougal, experimenting with the same form in New York, obtained thirteen. The Shirley poppies, whose petals show a narrow border of white, arose as a mutation of the common wild field poppy, and a few other plant mutations are known. They are all, however,—and even de Vries' Œnothera is probably no exception,—phenomena of artificial cultivation, under which man has always selected forms showing striking differences—*i.e.* he has selected variability, and gets it. In the animal kingdom even yet surprisingly few instances are on record to be added to those collected by Darwin. Of species in a state of nature mutations have been described in the case of a few insects, and amongst medusæ and freshwater fishes, but there is no evidence of these producing new races. Greater opportunities of observation are afforded by domesticated forms, and here, as Castle maintains, "the material used by breeders for the formation of new breeds consists almost exclusively of mutations. . . . On the whole, it appears that the formation of new breeds begins with the discovery of an exceptional individual, or with the production of such an individual by means of cross-breeding. Such exceptional individuals are mutations."[1] Stock registers show, he states, that "the beginnings of new breeds are small." A herd of polled Hereford cattle descended from a calf born at Atchison, Kansas, in 1889, cases of generations of polydactyly in human beings, Kennel's stump-tailed cat and Castle's guinea-pig with a supernumerary fourth digit both giving rise through several

[1] *Science*, vol. xxi. pp. 522, 524.

generations to similar offspring, are the kind of evidence that is offered in support of a theory supposed by many to supplant the Darwinian conception of variation in its relation to the origin of species. Not, however, of Natural Selection. On this point de Vries is most explicit: "Notwithstanding all these apparently unsurmountable difficulties, Darwin discovered the great principle which rules the evolution of organisms. It is the principle of Natural Selection. It is the sifting out of all organisms of minor worth through the struggle for life. It is only a sieve, and not a force of nature, no direct cause of improvement, as many of Darwin's adversaries, and unfortunately many of his followers also, have so often asserted. It is only a sieve, which decides which is to live, and what is to die."[1]

But our question was whether de Vries had suggested a truer account of the character of those variations upon which Natural Selection is admitted by him to work in the production of new species: and the answer is very doubtful. In the first place, it is difficult to distinguish between a large fluctuating variation and a small mutation. Even in the case of some larger mutations it still remains to be shown whether the apparent discontinuity may not simply be due to insufficient observation, and that the study of a still larger series of individuals might not result in the discovery of forms bridging the apparent gap. The mutation, de Vries avers on the strength of a decade of experimental generations, is always permanent; the fluctuating variation disappears. But much more evidence than he supplies is necessary for the support of both statements. Many mutations are comparatively stable; it does not follow that all are

[1] *Species and Varieties*, p. 6.

absolutely so. To base a theory of evolution on the fact that fluctuating variations are not fixed as the result of man's short experimentation with them, is to be blind to the possibilities in the patience of Nature, and to make an unwarrantable generalisation about all mutations. As a matter of probability, the mutation may not be so sharply delimited from the fluctuating variation as the incisiveness of statement of the opposing theories suggests. In any case, mutation and fluctuating variation are alike expressions of a ceaseless metabolism, just as the constant, internal motion of a large electric clock may reveal itself either in the creeping continuous movement of the hour hand or the leaping discontinuous movement of the minute hand. In any case, it is not yet disproved that all he is dealing with is patency and latency of characters: the latent character may not reappear until after many generations. In the second place, its value is impaired by the peculiar de Vriesian conception of a species. "Pedigree-culture is the method required," he says, "and any form which remains constant and distinct from its allies in the garden is to be considered as an elementary species. . . . Linnæus himself knew that in some cases all subdivisions of a species are of equal rank, together constituting the group called species. No one of them outranks the others: it is not a species with varieties, but a group consisting only of varieties. A closer inquiry into the cases treated in this manner, by the great master of systematic science, shows that here his varieties were exactly what we now call elementary species."[1] De Vries believes that the discontinuous variation appearing in one or more individuals will through its permanence constitute eventually an elementary species. New species arise

[1] *Op. cit.* pp. 12, 13.

by the selection of the fittest elementary species rather than individuals. This involves a conception of species as sharply distinct from one another, which is not what meets the eyes of the taxonomist in the world of living things. It is the continuity that baffles there. On the other hand, de Vries has done real service in introducing the conception of unit species characters that are incapable of divisibility and must therefore have arisen discontinuously, and which further will not blend in inheritance, but are handed on either dominant and so visible, or recessive and so latent. In the third place, not only is the evidence for mutations in a state of nature precariously small, but it is open to question whether de Vries himself, although laying such insistence on the necessity of thorough knowledge of pedigree, was right in his views of the origin and past history of his own experimental form. It has not been found wild in America, whence it was supposed to have come: quite possibly it is a domesticated hybrid,[1] produced by crossing various forms of the dimorphic *O. biennis*, which was definitely introduced into France from America in the eighteenth century. It is at least significant that de Vries found no hint of mutation—no revelation of latent characters—in the hundred other cases of native species that he investigated.[2] While, then, it is of great importance to know that such discontinuous variations do occur, and that on occasion they may result in the origin of new races, possibly of new species, there is absolutely no warrant for the extension of such a mode of origin to all existing species. We still await an unequivocal instance of the origin of a species in a state of nature

[1] G. A. Boulanger, *Journal of Botany*, Oct. 1907.

[2] Bateson has made the interesting suggestion that mutations may be simply pure Mendelian recessives appearing after a crossing (cf. p. 208 ff.).

from some discontinuous form or forms. The possibility is that both methods are in operation. Theoretically, quite apart from all demonstration, the idea of the mutation is very helpful. Man certainly varies in almost every feature of his physical frame, and it is not improbable that the pigmy races of Central Africa had their origin in a mutation. Man himself may have originated from his anthropoid ancestor as a discontinuous variation. In fact, the discontinuous variation conforms to the correct conception of a "break" as outlined at an earlier point.[1] "In view of the amount of orderly and well-authenticated evidence now at hand, it may be regarded as demonstrated that characters, and groups of characters, of appreciable physiological value, originate, appear in new combinations or become latent, in hereditary series of organisms, in such manner as to constitute distinct breaks in descent."[2]

Our second inquiry related to the determinate or other origin of these mutations. They are certainly in the first instance genetic; there is no question of their acquirement by use or disuse, or by the action of the environment. With this fact may be correlated their permanence. De Vries seems to consider their origin indeterminate. "In contrast with the fluctuating variations which are continuous changes in a linear direction, the transformations which we call mutations are given off in new directions. They take place, so far as experience goes, without definite direction, *i.e.* in the most diverse directions."[3] Apart from the apparent paradox involved in the conclusion,—which in any case is represented by no greater number than

[1] P. 129.

[2] MacDougal, *Science*, vol. xxi. p. 540.

[3] *Die Mutationstheorie*, vol. i. p. 150.

13,—it is remarkable that in seven successive generations, amongst several thousand *Œnothera lamarck.*, the mutant *nanella* appeared 5, 3, 60, 49, 9, 11, 21 times, and *oblonga* 176, 135, 29, 9, and 1 times in five successive generations, and similarly with the other forms.[1] As de Vries himself says, "a species, therefore, is not born only a single time, but repeatedly, in a large number of individuals and during a series of consecutive years." Now these mutants differ from one another not in one but in several characters, and the appearance of these different distinct forms in such considerable numbers in successive generations appears to banish fortuity out of court, and to compel belief in some measure at least of determination.

We have now learned a little about the manner of variation, but with regard to its actual cause we have made no progress, although it is obvious that in the solution of this problem our ultimate understanding of evolution will lie. We have as yet no sufficient explanation of the origin of variations or of that accumulation of them in definite directions that at a certain stage acquires selective value because of their utility. In these pre-selective moments the secret is hid, but it is a secret shared with the Environment, which may perhaps by skilful interrogation be prevailed upon to surrender it.

[1] The numbers of individuals examined in each generation were not equal.

CHAPTER VIII

HEREDITY

HEREDITY is the link, the genetic relation, which binds one generation to another. It is the expression by which we designate that well-known and long-observed tendency of plants and animals to resemble their immediate progenitors. In popular phrase the truth has been enshrined for ages. "Blood will tell," men say, suggesting that the past in some way determines the present: "the chip of the old block" is still the perpetual joy of his father's friends. Heredity is the great conservative factor in Evolution. It is the register alike of progress and regression: it is a perpetual guarantee against organic chaos and disorder. If there is something centrifugal, adventurous, and experimental in the widespread organic tendency to variation, there is that which is centripetal, steadying, and eminently contented in Heredity.

The outlook of Heredity is as broad as life, although there is just a chance that it is not as old as life. The earliest organisms, immensely variable, must have lived some time before a fund of heritable organic experience was collected. Viewed in its relation to man, Heredity provides the undertone of the Greek tragedian, the burden of the modern social reformer's cry of despair. It is that one of the Fates whom men think they know, into whose face they have looked and sometimes

found a friend, more often recognised an enemy. As a scientific problem it raises questions innumerable that touch man at every point of his complex being. Take but a single instance, that of the transmissibility of "acquired characters"—a question upon which there is yet no finality of judgment. Here is a matter whose practical aspects far outweigh in importance those that are theoretical: it touches man in every department of his being—physical, intellectual, and spiritual alike. In Sir Francis Galton's diction, Is Nature stronger than Nurture, or Nurture than Nature?

It is characteristic of the modern attitude that no investigator thinks that the general and particular problems of heredity are ultimately insoluble. Day by day the influence of ancestry is becoming more exactly known, as also the part played by various factors in determining the nature of offspring. The necessity of watching and acquainting ourselves with the development of modern science in this connection is peculiarly important in face of views upon the question that are racial in their influence if not in their groundwork of experience. Even the ancient Hebrews had a definite, and in many respects incontrovertible, theory of heredity.[1] They were at one with us in perceiving the difficulty of reconciling the apparently exclusive principles of the transmission of qualities from parent to child, and of personal responsibility: but we are nearer the solution than they. Meanwhile, the application in the practical sphere is very obvious, for preacher, physician, and social reformer are each compelled to note that men are not alike; that the same treatment is not suitable for every case; and that to be effective, reformation, moral and physical, must be not wholesale, but individual.

[1] Ex. xx. 5; Ezek. xviii. 2–4.

In a striking study entitled *The Heredity of Richard Roe*, President D. S. Jordan makes an analysis of the physical contents of the "pack" carried through life by the typical individual of that name. The handicap imposed by it varies so greatly with different individuals that when, as in the case of Roe's more famous prototype, the pack has become a great burden consciously or unconsciously borne, a whole school of modern philosophy will explain the one in terms of the other, and be ready to acquit the individual of all moral responsibility. This, however, is one of the final problems of heredity: let us first be present with Jordan at the inventorying of the pack.

As the son of his parents, Richard Roe has amongst its contents the burden of his humanity. No apology need be offered for this initial seeming confusion between the burden and the man, for it is an instructive biological fact that the man is the burden: his humanity itself is the main part of the contents of the pack. In common speech, we make a broad distinction between inheritance and inheritor, between property and heir; but in biology the fertilised egg cell is at once the potential heir and the inheritance. This obviously means a complexity of organisation and potentiality in the fertilised egg cell that almost seems incomprehensible, and yet it is difficult to escape the conclusion. The environment certainly plays its part in the supply of the necessary stimuli under whose gentle or rude influence development proceeds; still it is clear that in some measure involution must have preceded evolution. Again, his pack will have the distinctive inward and outward features connected with the racial group of travellers to which he belongs. That is to say, if he be of Celtic parentage, he will be in nature a Celt: there will be no Indian or Mongolian

characteristic associated with him. He will be fiery, but not with the passion of the south Italian; he will be imaginative, but not in the mental symbolism of the Oriental. Be he an Anglo-Saxon, he will, at least originally, have combined in him the balance of qualities that has given that people racial predominance.

But in addition to his common humanity and his racial qualities, there are in his pack characteristics that will be found in his and in his alone—viz. the individual qualities, the distinctive features, the peculiarities by which he is recognised as different from his fellow-packman. It is these distinctive physical differences that constitute the variation of the organic world. But there are mental differences and varieties of character and temperament that are no less important than these more material differences that we can weigh and measure. It is as if after every fresh creation Nature broke the die. She has no duplicates: one man is not as good or as bad as another. He is himself, and differs in a certain spacious way from every other being. The reason of this has appeared in the course of previous cell studies as they bore on heredity.[1] By the law of sex reproduction, Richard Roe has twice as many ancestors as either of his parents had. They may hand on to him any of the hereditary gifts that they received from their predecessors, and in any proportion. We might assume that half of his inheritance came from his father and half from his mother, but we are thrown out in that simple calculation when we find in him qualities that are not apparent in either his father or his mother. It is possible that the new features may be perfect blends of qualities that characterised his parents, but it is just as possible—

[1] P. 103.

and in many cases it can be shown—that they represent the characteristics of a yet older generation, so that there is a sense in which Richard Roe is a mosaic of his ancestry rather than an ego. That is to say, in his pack you will find parental qualities, but also those of his grandparents and of his great-grandparents, even of generations farther back: the contents of his pack are historic, samples of the distinguishing, as also of the very ordinary, features of his line.

Richard Roe, then, in his initial stage of a single fertilised egg cell seems simple enough, but the simplicity is seeming only. How in the mixed chromatin that constitutes the essential feature of the cell lie his potentialities of good and evil, together with the colour of his eyes, the tone of his voice, his peculiar gait—all, in short, that goes to make him what he is and what we know him by—transcends our powers of imagination. It is the wonder of the Infinite—the infinitely little, the infinitely great. In these chromatin granules of his two parents lie his capacities, but amongst them—perhaps latent, perhaps to be expressed—are qualities of past generations that were handed on to them. Not easily does the dead hand let go its grip either in law or in life, but the grasp becomes feebler as the ages roll on. Of the dual nature of inheritance no one has any doubt; but the conception of this larger multiple ancestral character of heredity—which is simply what we mean when we speak of the solidarity of the human race—is not so frequently before our minds. Yet obviously Richard Roe could not inherit all the peculiarities of his father or of his mother: he could not be composed of peculiarities alone. There is in him a great measure of the old common heritage which was his parents'

before him. Perhaps the most careful attempted statistical conclusion bearing on this subject is that known as Galton's Law of Ancestral Inheritance. It was elaborated as the result of that worker's biometrical investigations in the inheritance of such characters as vary continuously and are therefore measurable, *e.g.* human stature, and more particularly in connection with a series of observations on the coat-colour in Basset-hounds. What Sir Francis Galton maintained is that in the case of every inherited faculty the two parents contribute on an average one-half, *i.e.* each of them contributes a quarter of the individual peculiarity. The four grandparents between them contribute a quarter, or each of them one-sixteenth; and so on in the series $\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} \ldots$, obviously leaving one-quarter of the whole inheritance as coming down from the generations previous to that of the grandparents. Karl Pearson, approaching the problem in a slightly different manner, gives the series ·6244, ·1988, ·0630, *i.e.* he finds the parental bequest to be greater and the ancestral less than on the Galtonian scheme. As a matter of logic, Galton's Law simply gives us the induction that, on the average, offspring tend to resemble ancestors in certain definite degrees. His physiological deduction that these ancestors contribute in these definite proportions to the heritage of the descendants is strictly unproved. Further, his induction, like all such generalisations, can only be used in practice in dealing with the mass of cases. It is a statistical study, and is useless as a practical aid to any prediction in the individual instance. It deals with the fluctuating variations only, and is incapable of emphasising the import of the true variation or mutation.

There is one point of further interest. We note as a result of fertilisation a persistent tendency to

return to the type, and so keep up a specific average from generation to generation, in the absence of stringent selection. Karl Pearson offers a good statistical example. In the case of fathers 72 inches in height, the mean height of their sons was found to be 70·8 inches—a regression towards the mean of the general population; on the other hand, fathers with a mean height of 66 inches gave a group of sons whose mean height was 68·3 inches—*i.e.* they had progressed towards the mean of the general population of sons. "The father with a great excess of the character contributes sons with an excess but a less excess of it: the father with a great defect of the character contributes sons with a defect, but less defect of it. The general result is a sensible stability of type and variation from generation to generation."[1] This evident regression towards mediocrity, this tendency to approximate to the mean or average of the stock, is known as the Law of Filial Regression. The degree of regression becomes a measure of the intensity of inheritance. As enunciated by Galton in his *Natural Inheritance*, the bearing of the law is sometimes a little difficult to follow. "It must be clearly understood," however, he concludes, "that there is nothing in these statements to invalidate the general doctrine that the children of a gifted pair are much more likely to be gifted than the children of a mediocre pair. They merely express the fact that the ablest of all the children of a few gifted pairs is not likely to be as gifted as the ablest of all the children of a very great many mediocre pairs."[2] If you ask the statistician, How do you explain these phenomena of regression and progression? his answer is not far to seek. As Galton has it,

[1] *The Grammar of Science*, p. 456.
[2] *Op. cit.* p. 106.

society moves as a vast fraternity. A man is not merely the product of his parents but of his ancestry, which in the tenth generation will amount to some 1024 tenth grandparents—an ancestral population whose mean cannot differ greatly from that of the general population, unless there has been extraordinarily careful selection. "It is the heavy weight of this mediocre ancestry," says Pearson,[1] "which causes the son of an exceptional father to regress towards the general population mean: it is the balance of this sturdy commonplace which enables the son of a degenerate father to escape the whole burden of the parental ill." In other words, children tend to differ from mediocrity less than their parents—that is to say, "the mean deviation of the sons from the mean of the population is less than the deviation of the fathers."[2] This average ratio of the mean deviations of the sons to the deviations of the fathers is known as "the coefficient of correlation" between father and son for the particular character. For a number of characters it has been calculated to be ·48, *i.e.* on the average children deviate from the mean about half as much as the parent; with grandchildren the deviation is one-fourth. When the mean of the two parents is taken, a value is obtained which Galton has styled the "mid-parent," when the correlation already referred to will naturally be higher. It must be observed, however, that while the Pearsonian induction of a tendency on the part of exceptional groups to return towards mediocrity in the absence of direct interference by Natural Selection is sound, the accompanying deduction, that on cessation of selection the race or species tends to remain stable, is not absolutely valid. Apart from the case of

[1] *Op. cit.* p. 456.

[2] L. Doncaster, *Heredity*, p. 37.

small mutations which will be considered later, the actual appeal to reality shows that with fluctuating universal variations any cessation of selection results eventually in retrogression. The reason of this lies partly in the implications of Recapitulation, partly in those of biparental inheritance. We have seen that inasmuch as the individual recapitulates the parental development, it likewise recapitulates, though much more cursorily, the history of the race. Any retrogressive character therefore that appears must be of the nature of a reversion to some ancestral type—a sort of arrested development so far as failure to advance beyond that particular character is concerned. The ancestral influence might even be regarded as not represented or exerted *en masse*, so to speak, but in an orderly succession. As Archdall Reid says, "The so-called contributions of ancestors are nothing other than reversions—that is to say, failures to recapitulate the life-history beyond the points reached by the ancestors, or else the reappearance of hitherto dormant characters."[1] In the absence of Natural Selection these retrogressive variations tend to assert themselves: they have been so long established. Natural Selection has directly to do with progression: retrogression would thus appear to "plane away" redundant, useless variations. Further, this process is aided by biparental reproduction. Blended inheritance such as is usual in all except certain definite characters[2] tends to result in retrogression, in a return to the mean type, inasmuch as it substitutes the experience of the race in place of that of the individual. In fact, the function of sex reproduction seems to be to bring about retrogression—not in any

[1] *The Laws of Heredity*, by G. Archdall Reid, p. 209.

[2] The now well-recognised Mendelian characters. Cf. p. 208.

haphazard fashion, but by the elimination of useless characters without accompanying extinction of the individuals possessing them. "Progression, on the other hand, is caused through Natural Selection eliminating individuals that do not possess in a sufficient degree certain characters that prove useful in the struggle."[1] The blending produced as the result of sex reproduction tends to bring about the more or less rapid retrogression of useless characters—a retrogression that is only checked or reversed by Natural Selection.

On examination, then, the contents of Richard Roe's pack prove to be a composite of potentialities, the actualising or bringing to light of which depends so to speak on the weather in which the pack is subjected to scrutiny, and on the individuals around who have the interest and wisdom to pull out or push back these potentialities, as also on the packman himself. His personality, so largely built up out of elements that have, as it were, been actually used before him by many others, is the resultant, the *ensemble* of this interplay with the environment. If we fasten our eyes upon his immediate parentage only, we may be perplexed as to the possibility of progress in his individual life, but to do so is to forget that in him lie latent the potentialities of his remoter ancestry, and that if he be brought into the suitable environment they may be actualised. Often it is clearly demonstrated that special circumstances are required to bring a definite group of qualities into public action. Who would ever have heard of John Knox had it not been for the call of that St. Andrews congregation addressed to him at an age[2] previous to which most men have given the promise of their future? Instances can easily be multiplied of men

[1] G. Archdall Reid, *op. cit.* p. 198.

[2] Forty-two.

who were made by circumstances as opposed to those others who have made circumstances, and under Richard Roe's humble name there may lie concealed a noble heritage, which if latent in him, because up to a certain point he has not come under the influence of the appropriate stimuli, may yet be revealed in him or in another generation.

Richard Roe, we stated, had twice as many ancestors as either of his parents. Theoretically this is true: practically it certainly is not the case, owing to the intercrossing of families. In most lines of ancestry this must have occurred many times, and as a result a man's whole ancestry will generally be found re-entering at different points in his individual pedigree. So Kaiser Wilhelm II. might have had 16, 32, 64, 128 ancestors in generations four to eight; as a matter of fact he only had 14, 24, 44, 74, and the disproportion is even more marked in the previous generations. A common English family boast is that of descent from some one who came over to England with William the Conqueror. As a matter of fact any individual descended from two parents, four grandparents, eight great-grandparents, and so on, would be entitled at the end of the thirty generations between him and the Norman to an ancestry of some 8,598,094,592 souls, and it is only charitable to suppose that amongst that number there was at least one of whom he might be reasonably proud. But of course the number of Englishmen in William's or in any time is but a very small percentage of that total: most of the man's ancestors have been included in the tally several times. Descent is not so truthfully represented by a long chain, each link of which will stand for an individual who has left offspring, as by a network, very involved and extended, in which the

individual is represented by a strand that is related before and behind and on either side with other strands in this most complex web of life. Accordingly it is pretty certain that, as President Jordan remarks, "the blood of each person in Alfred's time who left capable descendants is represented in every family of England of strict English descent. In other words, every Englishman is descended from Alfred the Great: as very likely also from the peasant woman whose cakes Alfred is reputed to have allowed to burn. Moreover, there are few if any who do not share the blood of William the Conqueror, and most ancestral lines, if they could be traced, would go back to him by a hundred different strains. In fact, there are few families in the south and east of England who have not more Norman blood than the present royal family. The house of Guelph holds the throne not through nearness to William, but through primogeniture, a thing very different from heredity." The appeal to records, supposing them to exist, in the case of any individual of British extraction will produce results in this linkage of heredity not merely apparently paradoxical but which will establish the unity of blood not merely of nations but of all the individuals in any one nation however removed they may be by artificial social distinctions.[1]

Theories of Heredity.

Of theories of heredity, only one at present has any

[1] In the case of one family known to the writer descent goes straight back through nineteen generations to Alexander Cleland of Cleland and Margaret Wallace, an aunt of Sir William Wallace, on the one side, and as directly through the Stewarts to Robert Bruce on the other side. In both instances the line is traced through the great-grandmother, and the maternal great-grandmother traced her descent from Bruce through the genealogy of both father and mother.

serious following, and already it is evident how little of its earlier expressed outline is tenable. Nevertheless, with Weismann's name is associated a conception of heredity that has at least proved of great service in helping us to think clearly, so far as we may, upon this intricate question.[1] The conception depends ultimately on the division of the cells of living organisms into the two groups, somatic cells and germ cells. In the nuclei of the latter there is hidden away a mysterious living substance, vastly more complicated in molecular structure than protoplasm—the germ plasm — which is handed on from generation to generation and which, provided the appropriate nourishment is supplied, grows in quantity though remaining unchanged in character. Uninfluenced by anything in its environment, it remains inviolable in the body much as the gold concealed in the vaults of a bank. More particularly the theory involves these two assumptions: (1) the composition of germ plasm out of ultimate units called biophors, which though composed of several or many molecules represent single characteristics, and are aggregated into determinants which determine all the physical characteristics of the individuals resulting from the development of the germ plasm, for each determinant is the *anlage* (foundation) of a particular cell or group of cells. Further, these determinants occupy definite positions in the architecture of vital units of a third order called ids (= chromatin granules), and these in turn are aggregated into idants which are held to correspond to the chromosomes. (2) The second basal assumption is that of germinal continuity from one generation to another. The germ plasm lies secluded from somatic influence.

[1] *The Germ-Plasm: a Theory of Heredity* (1893); *The Evolution Theory* (1904).

The germ cell of one generation develops partly into the germ cells and partly into the somatic cells of the next generation. Germ plasm is convertible into somatic plasm, but not *vice versa.*

Development on this theory, so far as it relates to the body proper, is simply due to the increase and sifting apart through successive qualitative differentiating divisions of the ids of germ plasm until the particular determinants that control a cell or group of cells have been distributed in a definite and predetermined manner to their respective localities.[1]

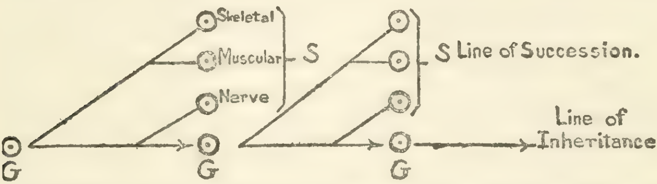


DIAGRAM ILLUSTRATING WEISMANN'S THEORY OF INHERITANCE.
G. The germ-cell, which by division gives rise to the body or soma (*S*) and to new germ-cells (*G*) which separate from the soma and repeat the process in each successive generation.

[*Modified from Wilson.*]

FIG. 7.

With such a qualitative distribution the longitudinal splitting of the chromosomes comes into remarkable association, as being the only method by which such an end could be attained. In the germ cells, on the contrary, growth and division are accompanied by quantitative distribution of the germ plasm, so that each germ cell contains identical hereditary matter,—will, in fact, contain the same characters as the original fertilised germ cell or egg: here also the phenomena of reduction and of fertilisation fall into line with essential features in the Weismannian account.

[1] The biophors differ qualitatively, and so do their aggregates.

In Weismann's words, "In development a part of the germ plasm (*i.e.* the essential germinal material) contained in the parent egg-cell is not used up in the construction of the body of the offspring, but is received unchanged for the formation of the germ cells of the following generation." These cells in no way contribute to the upbuilding of the body inside which they are maintained. Each of them is practically identical in power and character with the original egg, because of the method of ordinary division. They have been derived by direct descent from that egg, and there is therefore a sense in which the child is as old as the father. The second generation has, strictly, inherited nothing from the first. It is like it because it has developed from part of the same germ plasm. Accordingly, it is obvious why children tend to be like their parents. The differences between the generations are due to the fact that at every creation there is a mixing of two germ plasms of different ancestral origin. The genetic variations arising in this way being inborn tend to reappear in succeeding generations. On the other hand, no acquired characters can be transmitted. External influences only affect the somatic cells: such changes as take place there cannot be registered in the germ cells, although the latter may be directly modified by influences (*e.g.* poisons). It is only the character of the germ plasm that determines the inheritance of the subsequent generations. The individual is simply a trustee of the germ substance for future generations: no disasters which affect him, and no favourable circumstances either, can alter the character of the hereditary substance which he transmits to the next generation.

Such a conclusion, of course, cuts at the root of the whole Lamarckian interpretation of evolution, which

was based upon the inheritance of the acquired character, the transmitted influence of use and disuse being the fundamental law of that doctrine. Even Darwin admitted the part played by the Lamarckian factors in descent, turning to them whenever Natural Selection was faced by difficulties it could not solve. But if Weismann is right, the Lamarckian factors count for nothing. The environment does not affect the germ plasm, and cannot therefore affect posterity. Evolution is simply an evolution of germ plasm, and only incidentally of the individual. This necessarily involves Weismann in regarding all specific characters either as useful or correlated with useful characters. He further is compelled to explain the seeming effects of use and disuse either by Natural Selection, or by the withdrawal of selection in the case of non-useful characters.

It must be admitted that till quite recently no very satisfactory evidence has been adduced of the transmissibility of acquired characters. Ever since Weismann repeated the classical experiment of the farmer's wife and found out that the progeny of the mutilated mice were born with tails, a tendency has grown up to relegate the evidence for the transmission of acquired characters to the realms of mythology. Many circumstances which suggest such transmissibility are found upon strict examination to break down. It must be remembered that the change in the offspring must be strictly and definitely in the same direction as the original modification before we can speak of its inheritance. Many cases of what appear to be inheritance of an acquired character are probably not so correctly interpreted along those lines as in terms of the inheritance of a certain degeneracy of nature which may show itself in the same particular way in a child

as in its parent, but on the other hand may express itself in a totally different manner in the second generation. The degeneracy of nature thus handed on would be of course of the nature of a genetic character and therefore, *ex hypothesi*, heritable. It is not the acquired character that is inherited, but the innate power of acquiring it is transmitted. Then, again, there is no doubt that we must recognise the possibility of concomitant change of the germ cells along with the somatic cells. There is here no question of transmission, for the same cause may produce very different effects in the two generations. Further, all the germ cells might conceivably not be affected alike, and a difference of effect would be seen in the various members of the second generation. This seems to be the interpretation of results got by Standfuss from the experimental treatment of butterflies and other insects, *e.g.* submitting them to change of temperature. Finally, in the case of the higher forms we realise that all characters are developed under the action of different kinds of stimuli. The difficulty with the Lamarckian view is, as Archdall Reid has pointed out,[1] to see how an acquired modification can be transmuted into an innate character, how, that is to say, a character developed in one generation under the stimulus of use can be transferred in the second generation into a different category of stimuli, being now educed by nutriment, and how, being so transferred, it still can preserve its original utility. Nutriment is the fundamental stimulus, and under it all genetic characters develop. But there is no break, so to speak, between the modification and the genetic character. The whole difference is in the nature of the stimulus that has produced the modification or acquirement, and every

[1] *Principles of Heredity*, p. 19.

modification is ultimately a modification of some aspect of a genetic character. It is due to the superposition of the play of another stimulus upon the basal stimulus. Nourishment does not cease to work when use is modifying what nourishment has initially educed. The potentiality of this modification of a response is of course a genetic character, although the term here is vague compared *e.g.* with the potentiality to produce a Bourbon chin. Many modifications are as regular and constant as genetic characters because the individuals showing them experience identical stimuli at the same stage of growth.

It might be added that if organs and structures developed under use, then those most used would surely develop out of all proportion, and those that were little used we might suppose would degenerate. No organ is used more than the tongue, but beyond certain definite degrees there is no development of it. The history of man shows a gradual replacement of innate characters by modifications, which would not be the case if the Lamarckian view were the more profound. One of the most apparently decisive cases against transmission is furnished by the instincts of social bees and ants. These, which we might suppose to be acquired adaptations, are only developed in the workers, which do not lay eggs, whereas the transmission is through the queen and drones, in which these particular instincts are not developed.

On the other hand, it becomes increasingly clear that Weismann's conception, marvellously as it has fitted the facts up to a certain point, must be modified considerably if it is to hold its place. Thus there are facts which go to show that this germ plasm is not the absolutely stable substance that Weismann at least originally maintained it to be. Even if it were, how

could it have ever acquired any differences? Other facts, such as those of regeneration of lost parts amongst lower animals and budding in plants—even the ability of each of the cells of the 16-cell *Echinus* to reproduce a dwarf whole—prove that the germ plasm, if early segregated in the case of higher animals, is not necessarily restricted to the germ cells in the case of these humbler forms. This concentration and growing specialisation of cells seem to indicate the localisation and concentration that are the insignia of a higher life. Again, a feeling is expressed in some quarters as the result of experiment that every obvious effect produced in an organism may be accompanied by a more or less corresponding, though much slighter, effect upon the elements in the germ plasm, and express itself in the next generation as an apparently cumulative effect of the changed environment; or the effects may be totally invisible until, after generations of exposure to the influences, the inherent stability of the organism is overcome. Further, Semon in the last edition of his important work [1] quotes in support of his mnemic theory of inheritance some positive evidence of transmission that weakens the uncompromising attitude of the Weismannians. Semon, whose ideas are akin to those of Samuel Butler and Ewald Hering,[2] attempts to explain the phenomena of inheritance as due to a kind of unconscious memory, on the part of the developing organism, of the experiences of past generations. Such a position of course involves belief in the inheritance of acquired characters. He assumes that the germ cells like other cells can respond to stimuli by some definite alteration in their condition. The

[1] *Die Mneme als erhaltendes Prinzip im Wechsel des Organischen Geschehens* (3rd edit. 1911).

[2] They are also shared by Francis Darwin in this country.

stimuli to which they respond are changes in what he calls the "energetic situation" of the whole organism. The stimuli are supposed to leave a sort of lasting record of themselves—a "residual effect"—upon the germ cells. To this unified stimulation-complex the name of "engram" is given. These modifications of the germ cells affect their development, "because the engrams are called forth in due sequence by appropriate stimuli and express themselves in corresponding modifications of the body of the offspring. The germ cells are thus stored with the latent 'memories' of past generations, and they may contain many engrams that may never get the chance to express themselves in any particular individual ontogeny. Thus a number of alternative routes are open to each individual at the commencement of its life-history, and the particular route followed will depend upon the nature of the stimuli which the developing organism happens to encounter."[1] On such a view ontogeny is a mnemic phenomenon; it is of the nature of a habit. "Germ cells must, like nerve cells, contain engrams, and these engrams must be (like nerve-engrams) bonded together by association, so that they come into action one after another in a certain order automatically, *i.e.*, in the absence of the original stimuli."[2]

The most convincing data quoted by Semon are those of Bordage's peach trees[3] and Kammerer's

[1] Review by A. Dendy in *Nature*, vol. lxxxviii. p. 371.

[2] F. Darwin, Presidential Address, *B.A. Report*, 1908, p. 17.

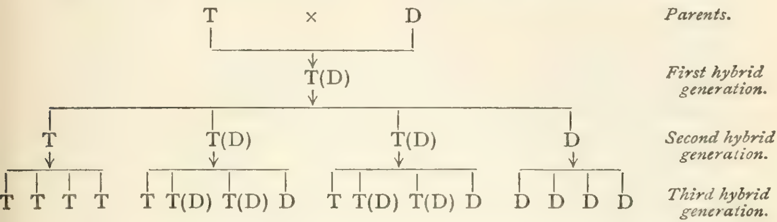
[3] *Op. cit.* p. 79. Bordage found that European peach trees grown in the coastal region of the tropical island of Réunion lost their deciduous character and became almost completely evergreen after twenty years. He further found that the seeds of these modified peach trees produced young evergreen peach trees when sown in another district at an elevation of over 3000 feet, where seeds of the ordinary peach tree produced the normal deciduous type in its temperate climate. Here evidently is a clear case of the transmission of a character acquired under the influence of change of climate.

experiments on the toad *Alytes obstetricans*. Semon avoids all molecular interpretation of the engrams, although he localises them chiefly, if not exclusively, in the nuclei of the germ cells. Nor does he attempt to explain how the necessary stimuli reach the germ cells, although the fact is held to be demonstrated in the experimental data cited. The circumstance that as yet no very acceptable suggestion has been made of the mechanism of such transmutation of modification into genetic character[1] can no longer blind us to the slowly accumulating data which seem to prove such transmutation. It certainly does not take place in every case; it may often be the work of generations; but roundly to deny the possibility on the strength of an imposing but far from invulnerable theory is not merely illogical, but is to disregard one of the best grounded generalisations of biology—the unity of the organism.

But especially has the Neo-Weismannian peace of mind been disturbed by the remarkable rediscovery of the facts first ascertained by Gregor Mendel, Prälat of the Königskloster in Brünn, about 1865. These bear on the heredity of hybrids, and establish the purity of certain germ characters. Mendel's procedure was to fix on definite unit characters (always found in alternative pairs) and study the manner of their inheritance: this was found to take place in perfectly distinctive and calculable ways. To take but one example: he crossed different varieties of the edible pea, *e.g.* the tall and the dwarf. In the first generation of this cross all were without exception tall. But in many of these the dwarfness proved to be latent, for in the next generation, each flower being self-fertilised, only 75

[1] See, however, A. Dendy, *Outlines of Evolutionary Biology*, pp. 185–193.

per cent. were tall, and the remainder were pure dwarf. The next generation produced as remarkable results. The dwarfs bred true; but of the 75 per cent. of tall, only one-third, *i.e.* 25 per cent., bred true: the remaining two-thirds produced 75 per cent. of tall and 25 per cent. of dwarf. Or in diagrammatic form,



Now, the implications of these and many other data are as follows: that in all forms of life as part of the inheritance there are regular, well-defined unit characters existing in pairs, which, when the possessors are crossed, do not blend, but appear the one or the other in the next generations in definite proportions; that one of these is dominant over the other, which is there in the individual resulting from the zygote, though invisible, and that either can be bred pure. Dominance seems to be due to some element which is wanting in the recessive. Mendel explained his results by segregation. He supposed that the germ cells of the hybrid contained one or the other of a pair of alternatives (allelomorphs) but not both, as in the case of the hybrid zygote of the first generation, and that these gametes are produced in equal numbers. Offspring in which similar individuals of a pair are united will breed true to the character in question, irrespective of their ancestry. In the case of the edible pea Mendel found several pairs of alternative characters. Purple and white flowers, rounded and wrinkled seeds,

and so on, were proved to be dominant and recessive respectively. Now various new pure combinations of these allelomorphs can be obtained. For by crossing the tall purple with the short white, we get not merely these forms in the second generation, but also short purple and tall white, and by selecting the pure individuals, pure races of the new types can be established. It is as if without altering the fundamental character of a building different individual stones could be substituted in the place of others. In some more complex cases, allelomorphs of distinct pairs react on one another so as to produce a linked or grouped effect in the individuals possessing them. The practical value of the discovery lies in the fact that, to take another example, it is found that in wheat, resistance and non-resistance to the attacks of disease, earliness and lateness of ripening, good and bad milling quality, strength and weakness of stem, are all pairs of Mendelian alternatives, and it has been found possible to take a different example of these qualities from each of these different strains and combine them together in a single new variety with perfect certainty in four generations. It has been found possible by crossing immune and non-immune strains to obtain a pure rust-free wheat in three generations, thus answering the old question, "Who can bring a clean thing out of an unclean?" and answering it differently from Job. The Mendelian formula may thus be applied to the individual with definite prediction: the statistical study of heredity bears only on the group. The former is practical; the latter is theoretic. The conflict with Weismannism lies in this, that while the latter assumes that the characters of members of any ancestral generation may be equally represented in each germ cell of the descendant,

Mendel's experiments show that while all essential characters are represented in every germ cell, yet the distinctive Mendelian characters are represented by a paternal or a maternal determinant only, and not by both. Still less, then, are all immediate ancestors probably represented in the germ cells in respect of any particular character.

Again, Darwin's idea of evolution supposed that it was achieved by the continuous and gradual alteration of the specific mean through the selection of fluctuating variations. This is the view of the biometrician, in part conditioned by his method. He deals with great numbers of individuals; he notes the continued tendency of offspring to regress towards the mean. His biggest variations are not isolated, being linked with others by intermediate degrees. The Mendelian does not deny the existence of those normal fluctuating variations; but he insists that they are useless to evolution. They tend to return to the mean so strongly in succeeding generations that they cannot, under any degree of stringency, serve as elements of permanent racial divergence. And he thinks that evolution proceeds by the selection of the non-blending discontinuous stable variation: these are the characters he is likely to notice, for he works with individuals rather than with aggregates. Some of the offspring will show this discontinuous variation: others will not. If it is favourable, it will be preserved: if it is not, it will be lost.

Obviously the question as to what extent characters of parents do or do not blend in offspring or may be found with the distinctive Mendelian relations is one which can only be decided by observation and experiment. Criticism of these relations cannot obliterate the basal facts. It is assuredly the case that no

one of these features is absolute. Dominance is sometimes incomplete: the influence of the recessive shows itself in greater or less degree. Sometimes a common ancestral form appears in place of either dominant or recessive. In the words of the First Report to the Evolution Committee of the Royal Society,[1] "Dominance is a phenomenon presenting various degrees of intensity;" or, in Davenport's words, "It is a matter of degree, not of kind." The hypothesis is useful though unverifiable that Mendelian characters are represented by units in the germ plasm,—itself an assumption. Nevertheless, the heredity of many characters in many species of animals and plants is found to be intelligible from Mendel's point of view.

How far the Mendelian law applies to man is a question to which as yet an answer is not forthcoming. It is obvious that the practical study of human heredity must offer difficulties that are peculiar to the case. Human families are not large as a rule, and cannot be the subject of experiment; four generations require a century, and records are rarely preserved with care. Further, it is extremely probable that, owing to the long line of ancestry that leads up to man, human characters are very subtle complexes which will require much disarticulation before we understand the unit characters out of which they are built, and it is these unit characters whose behaviour is expressible in terms of the Mendelian law. The Mendelian formula is as yet inapplicable to the inheritance of mental traits precisely because the psychologist has not yet enabled us to analyse even the simplest psychical characters into their fundamental units. On the other hand, in a rough general way we have the

[1] By Miss Saunders and W. Bateson, 1902, p. 126.

data of generations as we have them in the case of no other creature, and it is already clear that certain characters do conform to a Mendelian interpretation of their transmissibility. If blending is indeed the rule in human inheritance, a blending that is more rather than less permanent, if the features that most markedly follow Mendel's law are abnormalities rather than normalities, perhaps this very circumstance should awaken us to the possibility of practical treatment of them. Of normal characters, eye-colour has so far provided the best demonstration. It is probable that "the complexity of the transmission of the various colour-characters,"[1] *e.g.* eye and hair, is greater in the case of our mixed Western European populations than it is amongst plants and lower animals. The presence of pigment on the front of the iris gives us brown or black eyes: its absence produces blue or grey eyes. The results of Hurst's investigations on the parents and children of a Leicestershire village go to show that brown eyes are dominant to blue eyes. Again, "the segregation of red hair from black hair may be seen in many families, and this red is presumably a recessive."[2] In the case of disease and malformations a close study of their transmission has been undertaken along these lines, and the indications so far are that in the majority of instances the abnormal feature is dominant to the normal. Brachydactyly and cataract, to take but two examples, prove themselves transmissible in the proportions expected. Albinism and one or two rarer pathological conditions prove themselves recessive. As yet we do not know if immunity to specific diseases follows Mendelian lines, although it becomes increasingly evident that such immunity has

[1] W. Bateson's *Mendel's Principles of Heredity*, p. 205.
[2] *Op. cit.* p. 206.

been a very real element in human evolution. The recessive character is distinguishable by the fact that it is observed in the children of parents who are without it, and particularly in the offspring of consanguineous marriages. Further, it becomes increasingly probable that the dominant condition is due to the presence of some element added to the normal composition of the body, while the recessive type of disease is due to the absence of some element that we may expect in the normal body. Finally, this discussion of the dominant and recessive characters of specific diseases will banish any preconceived association of dominant characters with qualities that from another point of view we may consider "good." As a matter of fact, we know that in wheat resistance to rust disease is a recessive: that is to say, the good has to be won from the evil, and the condition of its existence probably consists in the absence of some element found in ordinary wheats whose presence renders them an easy prey to the rust-fungus.

Of the typical Mendelian phenomenon there is no doubt. It is a verifiable account of what takes place as the result of the hybridisation or crossing of forms at some stage or other in the ancestral history. Further, the results square with Weismann's architectonic conception of the germ plasm, while segregation fits in with the distinctive evolutions of the reducing division. On the other hand, the occasional imperfect dominance exhibited, or the admitted difficulty of elucidating certain results in a strict Mendelian sequence, may very easily be due to the unrealised degree of complexity of the inheritance, and to the fact that the dominance of one of a pair of characters may be linked with the presence or absence of a constituent of some other pair. What is apparent is

a realm of order in these deepest aspects of the continuity of life.

Inheritance of Mental Characters.

To leave physical characters and pass to the general consideration of the inheritance of mental and moral features is to enter a field where qualitative rather than quantitative tests must ultimately prevail. Nevertheless, as far back as 1869 Galton in his work *Hereditary Genius* showed that within a certain range the quantitative test produced results. Later, Karl Pearson applying the statistical methods used in calculating the inheritance of physical characters to data furnished by school teachers' reports on such characters as popularity, vivacity, ability, and handwriting in their scholars,[1] maintained that "the degree of resemblance of the physical and mental characters of children is one and the same," or more concretely, "we inherit our parents' temper, our parents' conscientiousness, shyness, and ability as we inherit their stature, forearm, and span." With regard to Pearson's particular method of argumentation it should however be noticed, that because certain characters appear in certain similar proportions it does not necessarily follow that they are both "innate." There are other characters in which presumably similar degrees of likeness could be shown, *e.g.* ability to speak or write the English language, which are obviously acquirements and not innate. Pearson can show the degrees in which certain definite characters are reproduced under certain definite conditions, but he offers us no criterion by which to decide whether characters are innate or acquired.

[1] "On the Inheritance of the Mental and Moral Characters in Man, and its Comparison with the Inheritance of the Physical Characters" (Huxley Lecture for 1903, *Journal Anthropological Institute*, vol. xxxii. pp. 179–237).

The fundamental similarities in racial, national, and even occupational mental character, the universal re-emergence of primitive instincts, feelings, and specific responses to stimuli, seem to point in the direction of some degree of inheritance in the lower reaches of mentality. Possibly the initiatives of moral character are transmissible just as physical tendencies are: temperament, emotional nature, strength of will, judgment may all be in great measure hereditarily determined. What we must recognise is that physical characters are almost entirely fixed by heredity: in modification of them man cannot do very much. They are genetic and transmissible, and improvement is appallingly slow. In the case of certain grades of mental characteristic the same holds true, but as we rise in the scale of those mental, moral, and spiritual features that are most distinctive of man, we realise that increasingly they are of the nature of acquirements. The distinction between the genetic character and the acquired character or modification thus comes to be peculiarly important in the case of man. Consciousness and the power of memory which stores the impressions of consciousness are genetic characters, as also the power of thought, which is so intimately associated with the other two: their stores are all acquirements. Man has few instincts and they are limited to the earlier phases of his life, so we have the long helpless period of infancy when the power of acquiring is slowly maturing, and developing behind a few protective instincts. All the rest of his mental and spiritual life is of the nature of acquirement; in fact, the ability to make acquirements is a distinguishing feature of man. He is, as Shaler long ago remarked, essentially the "educable" animal. On the other hand, the whole life of many animals is instinctive in activity: all their

characters are inborn. There are none of those modifications that arise as the result of consciousness. As we ascend in the animal scale, the growing feature is the increasing power of devising and making acquirements. The more instinctive the life, the more is it a uniformity from beginning to end: the insect is practically as clever on its birthday as on the day of its death. The less instinctive the life, the more guided by intelligence, the less of a uniformity is it, and the more of a progressive growth. Social customs, morality, religion are the result of nurture, and in those spheres the environment has the determining and final word.

CHAPTER IX

SOME SOCIOLOGICAL ASPECTS OF HEREDITY

In the case of man it is obvious that questions of Heredity and of the influence of Natural Selection take on a somewhat different guise from that which they wear in the case of humbler forms of life. Not merely is there little of the struggle for existence in its life-and-death aspect amongst the human races of to-day, but we become at once aware of numerous ways in which man in virtue of his educability and mental plasticity can modify and in part create some of the elements in his environment, so that Natural Selection, so far as he is concerned, is gradually being replaced by Rational Selection.[1] Every stage in the evolution of forms below man bears a direct and constant relation to the physical environment mainly. In the case of man a distinction has arisen whereby the strictly biological aspects of human evolution, directly related to the physical environment as with the lower forms, have not stood in any close association with that social evolution that has been so marked a feature of mankind. His ability to preserve and make use of the social experience of the past has led to a certain disparity of advance between his social evolution and that biological evolution which means change in

[1] A great though not permanent exception, however, still remains in the case of zymotic disease.

innate character. Progress in the former sphere is obvious: in the latter it is hard to demonstrate. Even such an old type of Natural Selection as war, in killing off the biologically fit, and in time of peace giving an advantage economically to the physically defective, operates in a method precisely the reverse of that which underlay its practice in earlier stages of civilisation.

Hitherto man's interference with the factors that operate in the biological evolution of the race, such as natural selection, sexual selection, isolation, and so on, has had no direct relation to the factors operating to bring about social evolution. The time is approaching, however, when these two aspects will be kept in constant conscious association. A variety of circumstances is combining to quicken reflection upon the kind of use that is being made by man of his power of consciously modifying in part his own evolution. The issue is raised in connection with modern methods of procedure in the production of national efficiency, about which it may be fairly questioned whether they are not producing results that may ultimately be nothing less than disastrous. Inquiry arises on many sides as to whether the particular modern trend of social progress is really progressive and tending towards a biological improvement of the race. In the strictly scientific use of the term the struggle for existence results in the survival and reproduction of certain fittest forms: whatever content there is in this fitness, it is something physical. In the case of the human species there is, however, little struggle in this sense, as we have seen; indeed, it is the physical unfitness in the form of "national degeneracy" that at once arrests attention in connection with this easing up of the struggle. History has already compelled the

question why imperial races rather than their conquered subjects have ultimately degenerated—why it is that nothing *fails* like success? The problem to be considered is whether the particular lessening of the stringency of selection is compensated for by the undoubted greater fitness of social life and institutions, into which channel the force of evolution is being directed by man himself.

It may be considered first from the point of view of the present declining birth-rate, to which Karl Pearson[1] and others[2] have lately called attention. The total number of births registered in 1910 in England and Wales was 896,962, equal to 25·1 per 1000. This is no less than 2·5 per 1000 below the average in the preceding decennium, and 0·7 below the rate in 1909: in 1876 the births were equal to 36·3 per 1000. The Registrar-General's report indicates further that the trend of the birth-rate is still downwards, the provisional rate for 1911 being yet lower, viz. 24·4 per 1000. Nor is the decline confined to the mother country. In thirty years the birth-rate in Australia has fallen from 35·2 to 26·7 per 1000, and in New Zealand from 36·3 to 26·2. A phenomenon, therefore, which has hitherto been prominent in France confronts whole English-speaking portions of the empire. If the diminution of the birth-rate could be shown to prevail among the unfit, the phenomenon might be viewed without apprehension: it might even be welcomed in evidence of the existence of noble and self-denying ideals. Statistics, however, prove conclusively that the decline is most marked in the middle and professional classes, where the intelligence and physical ability of the nation are to the greatest extent segregated. As

[1] Cf. *National Life from the Standpoint of Science.*

[2] *e.g.* the Bishop of Ripon at the Anglican Church Congress in 1910.

a result these are being steadily recruited from the lower and less intelligent strata of society, or to put it in other words, there is a gradual breeding out of intelligence. If present tendencies continue, the proportion of the fit to the unfit will steadily decline. Further careful statistics show that the birth-rates in the various districts of our cities are in inverse ratio to their wealth, that, over all, the upper classes tend to marry later in life with decreasing fertility, and that the population tends to be recruited chiefly from the earlier marrying so-called lower strata of society.

It is also noteworthy that the decline of the birth-rate in the British Empire synchronises with an increase in the birth-rate in the East. The remarkable emigration from China to various localities suggests a pressure due to over-multiplication which can only be roughly estimated in the case of that tremendous population. In the twenty-three years between 1886 and 1909, when the birth-rate in the United Kingdom fell from 31·4 to 25·8, the birth-rate in Japan rose from 28·5 to 34·2—her rise being greater than our fall. From the same date to 1910 Ceylon shows an increase from 30·3 to 39. "It is not going too far," says the Bishop of Ripon, "to say that while the populations which claim Western civilisation show signs of diminished fertility, the East is growing in consciousness of strength, in alertness of perception, in supple power of adaptation, in vigour, self-denial, and numbers. Are we witnessing the decline of the West and the rise of the East? Are the nations that have been entrusted with the guardianship of the Christian faith refusing their inheritance, and by an inexplicable race suicide surrendering the sceptre to the East?"[1]

Again, of undesirable variations from the racial mean

[1] *Report of the Church Congress*, 1910, p. 166.

fraught with serious consequence none are more deadly than insanity and feeble-mindedness; yet man's interference with his own evolution, however questionably successful in other directions, has not been exercised in any suitable degree in the worthy and practicable aim of checking such tainted streams as have flowed continuously for several generations. Mental disease is undoubtedly increasing at a rate which is out of all proportion to the increase of the population. It is hereditary; indeed, its only true treatment is prevention. From evidence given before the Royal Commission on the Care and Control of the Feeble-minded (1904) we learn that in England and Wales 271,607 persons may be considered as suffering from mental defect, of whom, apart from the certified lunatic, 150,000 are not sane but are not certifiable, while 66,500 urgently need proper supervision.[1] Of the inmates of the Poor Law institutions, excluding pauper lunatics, from 12 to 18 per cent. are mentally defective, and in the prisons there are to be found every day from 3000 to 4000 defectives. Evidently, then, we have a great mass of mental degeneracy which when it is not living at the cost of the tax-payer in workhouse or in prison, or being supported by charity,[2] is wandering about the community, idling and working mischief, or settling down and reproducing its kind at abnormal rates.[3]

[1] According to the latest returns the number of certified insane persons under care in England and Wales on 1st January 1912 was 135,661, or 2504 more than in the previous year. The ratio of insane individuals to the population has increased during the last fifty-three years by 98·8 per cent., till now the proportion is 1 in 269.

[2] The annual cost of maintenance of mentally defective children, paupers, and prisoners amounts to about £635,000. Under the recommendations of the Royal Commission on the Care and Control of the Feeble-minded, this figure would be raised to £1,175,000.

[3] The average normal family (parents excluded) is four: in the degenerate family the average number of children born is eight.

As a part result we find in the elementary schools 35,662 mentally defective children, of whom some 50 per cent. will never be able to earn their own living. Into the causation of this increase in mental degeneracy, apart from genetic strains, several factors enter—alcoholism, general progressive paralysis with all that its etiology implies, and the pressure of economic life.

A third feature with disquieting implications is the complacent perpetuation of certain criminal strains that in their persistency almost seem analogous to a Mendelian extracted pure character. Some of these are very closely connected with the condition previously examined. Probably the best known instance is R. A. Dugdale's study of "The Jukes." This he began in 1874 as a New York State Prison Commissioner. "The Jukes" is the name given by him to a large group of degenerates. It is not the real name of any family, but a generic term applied to 42 different families, whose inter-relationships were made the subject of investigation. The word "juke" means to roost, and is used by Dugdale to designate the members of this tribe of Ishmael who failed to rear good homes, or provide themselves with the necessaries of life by honest, steady work. Dugdale, in the course of his prison investigations, was surprised to find six criminals in one prison who, though under four family names, proved to be blood relations in different degrees. Accordingly he set to work to unravel the history of the tribe. He traced it back, on the one side, to an individual he calls "Max," born between 1720 and 1740 of Dutch stock, who lived a kind of backwoodsman's life in a lake district of New York State, but was essentially an easy-going, dissolute man. The starting-point on the other side is furnished by a group of six women, sisters in some degree, two

of whom married two of Max's many sons. Dugdale learned details of 834 descendants of seven of this group through as many generations, and with collateral lines traced the history of 1200 "Jukes." The almost universal traits of the tribe were idleness, ignorance, and poverty, all combined with great vitality. Their refusal to work or to study led to disease and disgrace, to pauperism and crime, to feeble-mindedness and insanity. Nor did their crimes or their pauperism show any redeeming feature: it was all sordid, with nothing heroic, clever, or honourable. So far from contributing to the world's prosperity, they cost the State more than 1000 dollars apiece in seventy-five years, including men, women, and children. Those who worked did the most menial labour, commanding the poorest wages. Of the total number of men, not 20 were skilled workmen, and 10 of those learned their trades in the State Prison. None of them was regularly employed, and the study of this tribal indolence and inability to persist in any task owing to lack of discipline and education, indicates that it is easier to reform a criminal than a pauper. Of the 1200, some 300 died in infancy from lack of proper care and favourable conditions. Of the remainder, 280 were professional paupers who lived in poorhouses or their equivalent for 2300 years. More than 50 per cent. of the women led lives of notorious debauchery; 440 men and women were physically wrecked in early life by their own wickedness; 60 were habitual thieves; 140 were convicted criminals, and 7 were murderers. These summed results arrest attention, but even more impressive is the detailed study of the several family lines, generation after generation, which brings out a tendency to the segregation of licentiousness, criminality, and pauperism in the different strains. Of

a similar character, and with still more detail, is Jörger's unravelling of the Swiss family "Zero."[1]

These may appear extreme cases, but in a paper read at the Church Congress in 1910,[2] Mrs. Pinsent of Birmingham cited several cases of mentally defective families in which mental defect and criminal propensities could be traced through three or four generations. The cost of such families to the community, she pointed out, was very large. Fourteen individuals out of nineteen in the third generation of one family with only a single normal representative had been supported at public expense in industrial schools, prisons, reformatories, asylums, workhouses, and homes. Five publicly paid officials were constantly visiting one other family, where a mentally deficient mother had borne ten children, four of whom were mentally defective and two physically defective, while three died in infancy. The whole of the time and money spent on improving the environment of this family was wasted, for in spite of the united efforts of these five officials not one of these children could possibly become a useful citizen. The training and support of these degenerate families ultimately falls so heavily on the efficient members of a community that they are sometimes led to limit the number of their children and also the educational opportunities they could afford them, thereby impairing their usefulness.

By way of contrast the story of Jonathan Edwards' descendants may be set down.[3] The great American divine was born in 1703. He had eleven children, and a study has been made of 1400 of his descendants,

[1] *Archiv. für Rassen und Gesellschafts Biologie*, Berlin, 1905, ii. pp. 494–559.

[2] *Report of the Church Congress*, p. 151.

[3] A. E. Winship, *Jukes-Edwards*, chap. ii.

which includes those men who have married into the family. Of these, amongst the men alone—and the record is not so complete as in the case of the Jukes—285 were college graduates, including 13 presidents of universities and colleges, 65 professors, and many principals of important academies and seminaries. Every department of learning and human activity in the United States has been adorned by men of distinction belonging to that family, while there was not a single criminal or pauper amongst them to stain the family name.[1] At every point the contrast with the Jukes is very striking, and again suggests the analogy of an extracted Mendelian pure character. Further contrasts in inheritance of ability, musical, religious, scientific, and criminal, may be found in various classical studies.

Another criterion whereby the efficiency of man's interference with his evolution may be gauged is found in the growing increase in the rate of suicide. The isolated accounts of suicide in the newspapers lead us to think of it as an individual affection. This is very far from being the case: indeed, in some morbid conditions, *e.g.* amongst Russian political prisoners, it has sometimes become epidemic. Further, the tendency shows a marked increase not merely in Great Britain,—where for England and Wales the Registrar-General in his Annual Report for 1910 gives figures that show an increase of from 86 to 100 per million during 1891–1910,—but in most countries of Europe. In St. Petersburg, a city whose population including that of the suburbs was 1,927,000 people in 1909, there were 1432 cases of suicide, a figure which shows a marked increase on that of any year in the previous decade.

[1] The name of Aaron Burr may occur to some as an exception; if so, he is a remarkable exception wherewith to prove the rule.

When we attempt to elucidate the causation of suicide, the common but often unreasoned association with insanity by coroners' juries may easily lead us very far astray, as the following human document from the pen of a Russian student will show. "Fancy you see before yourself a man who is ill with an incurable illness—tuberculosis. He is at present not more than twenty-one years of age: in four years this man will not be on earth any more. The thought of the inevitable death causes such experiences for the depiction of which there are no expressions in our language. This thought poisons the remnant of life which remains to him. I do not now speak of physical sufferings. Would it not be better for such a man to deliver himself and others from such an existence on earth? Logic says the following: (1) That the earth is too small for humanity: if some did not die, others would not have room or means for existence. (2) If God exists, then maybe on the other shore a man will get something better than sleepless nights and an endless deadly craving. (3) If God does not exist, and if death is only a return to the condition in which a man was before his birth, then it is better at once to be delivered from all this torment. HCN (prussic acid) kills instantaneously and without suffering: true, the rest is silence, but better eternal silence than four years of inquisition. I greatly beg you to answer, because this question is from one of those whom you see before you, a question of the present day, a question of life and death. I have courage to do away with myself, but I would wish to act in accordance with higher truth."

If there were a regular direct connection between insanity and suicide we should expect that the sex and country with the highest insanity records would

show the heaviest suicide-rate. This, however, is very far from being the case. Statistics show that while insanity is on the whole slightly more prevalent amongst women than amongst men (although the difference is as much as 11 per cent. in the case of Norway), suicide is markedly more characteristic of the male than of the female sex. Norway and Scotland, according to figures that cover periods in the second half of last century, stand first and second in the insanity record of nine European countries; but on the corresponding suicide record their places are fourth and eighth. Denmark and Saxony, where suicide is most common, are third and eighth in the insanity returns.[1]

More interesting is the clearly proved fact that suicide is much more common in Protestant than in Roman Catholic communities. A recent examination of the returns from Switzerland shows that in the French-speaking Catholic cantons the suicides number 119 per million inhabitants; in French-speaking Protestant cantons, 352; in German-speaking Catholic cantons, 137; in German-speaking Protestant cantons, 307. In Protestant Saxony on a ten-year average there were 330 suicides for each million inhabitants; in France, 225; Austria, 163; Italy, 58; Spain, 18. The reason of this is, in part, probably bound up with the greater social integration and cohesion of Roman communities. Not even the proverbially integrated Jews, welded together under the pressure of an unsympathetic environment, show so light a suicide-rate. Liberty is essentially disruptive, be it expressed in thought or social institution: the parasite has always the sheltering host.

[1] These figures are taken from G. Chatterton-Hill's judicial study, *Heredity and Selection in Sociology*.

Again, suicide for reasons akin to those that we have already considered is much less common in family circles than in the case of the isolated life. Careful statistical study once more proves how family life acts as a determining factor in social integration, especially in the presence of children in a family. Suicide is in fact a social phenomenon that obeys laws of its own, laws that sometimes run counter to those that govern the individual life, as in the proved correlation between periods of commercial prosperity and increase in the suicide-rate, or the restraining and integrating effect of crises and their awakening of responsibility in the national life. In short, suicide, in Chatterton-Hill's words, is "directly dependent for its decrease or increase on the greater or lesser integration of society."[1]

If now we seek to inquire along what lines social evolution is actually proceeding consciously or unconsciously in relation to such matters, we find a curiously contradictory result. It will be noted that endeavours to reduce the infant mortality amongst the working classes are being attended with marked success, and satisfaction may also be found in our present system of free education, supplemented latterly by free meals for school children, and even the conveyance of invalid children to schools. To no one of these activities will the philanthropist object: the only question is to what degree, if at all, they constitute alone a real solution of the problem of which they are a phase. It is not enough to regard the feeding of hungry children and the assistance of those who are handicapped as present pitiable necessities; the time has come to institute inquiry into the conditions under which such necessities arise. The difficulty is that, almost immediately, the inquirer is made to feel that

[1] *Op. cit.* p. 218.

the whole problem is intimately associated with that of the liberty of the individual, any imagined infringement of which is at once viewed with suspicion. The liberty of the individual has, however, in this country simply become a fetish, upon whose altar thousands of lives are annually sacrificed. In the name of an already surrendered liberty the best redemptive racial and individual endeavour is consistently opposed.

There can be little doubt that in proportion as the State takes upon itself the education, upkeep, and supervision of the child, it tends in that degree to give doubtful encouragement towards increasing the birth-rate of the least physically capable elements of the community, and to lessen the sense of parental responsibility in quarters where it is often slightly enough developed.[1] It may even destroy one of the strongest parental incentives to labour, and it tends to have a deadening, if not an alienating, influence on all those filial affections that are a stimulus to virtuous devotion. The cry for a higher birth-rate ought to apply strictly to desirables. The death-rate for England and Wales during 1910 was 13·5 per 1000 as against 21·7 in 1851–1855: this is the lowest on record. The reduction was mainly due, however, to a conspicuous fall in the infantile death-rate. Under the improved conditions it is the less fit forms that benefit more than the fit. Where, as the result of modern appliances and greater efficiency, it is found that infant mortality, as *e.g.* in tuberculosis, has been very greatly

[1] "The Coroner (to a witness at Southwark to-day): How many children has your wife had? Witness: Well, about fourteen. The Coroner: You say 'about.' Can't you remember the exact number? Witness: Well, she has had so many I can't remember. The Coroner: My officer puts it down at sixteen. Is that about right? Witness: Yes, sir, about sixteen. Another witness stated that the correct number was sixteen."—*Westminster Gazette*, January 27, 1911.

reduced, we yet find that the death-rate tends to increase in the case of males of forty-five years and upwards. That is to say, by our increased care we are permitting the survival and multiplication of the individuals that will probably reduce the racial efficiency, while it appears that those in the best years of manhood are dying at that period at an increasing rate. The very humanitarianism of some of the tendencies embodied in present-day legislation conceals very real dangers to racial progress. The probability is that while immediately reducing suffering they will in reality increase it for the generations to come. It is the sickly and predisposed that have benefited out of all proportion by recent hygienic advance and civilisation, thus increasing the keenness of the struggle for the more fit. Our vaunted saving of life does not affect the best life, and means a growth and increase of the feebler, weaklier life. It is not the expansive elements or individuals in the national life that are assisted.

To strive to find out the conditions of this organic fitness which is prior to social progress is not to appear in the guise of an ogre, or because of obvious defects to advocate a return to Spartan ideals. But it is to suggest that, as the sense of national solidarity and responsibility grows and the feeling of duty towards the future takes more definite shape as a national and religious ideal, we shall realise the necessity of being not less humanitarian but more providently so, in such a way that our care for the race will enter into our care of the individual, and physical weakness be prevented from reproducing itself in forms that can only be a menace to national life, and pain and suffering to the individual life. Whatever hinders that expansiveness which is the secret of progress is treachery to human life. If we do not allow Natural Selection to act on

the rapidly increasing undesirable elements of population for their elimination—and this would be contrary to every instinct of higher civilisation—then the only other alternative is to control that multiplication. The work of combating drink and disease, indeed of all physical and moral redemption, is largely lost on the race, and has to be done over again for another generation, if nothing at the same time is done to check the multiplication of long proven strains of biologically and morally degenerate individuals. The Weismannian doctrine of the unchanged germ plasm, inadmissible in great measure as we believe it to be, may yet serve to remind us that the moral individual change may not easily or quickly affect the degenerate constitution. This, however, is certain, that any effect that training and education—however beneficial to the individual—may have upon the stock itself is largely nullified so long as we shrink from the duty of considering and dealing with the conditions under which in so many instances that stock is being maintained. Bernard Shaw's most modest claim, perhaps, would be that of a serious writer, yet in the Dedicatory Epistle in *Man and Superman* there is this arresting passage: "Promiscuous breeding has produced a weakness of character that is too timid to face the full stringency of a thoroughly competitive struggle for existence and too lazy and petty to organise the commonwealth co-operatively. Being cowards, we defeat natural selection under cover of philanthropy: being sluggards, we neglect artificial selection under cover of delicacy and morality."[1] In Christianity there is fortunately a proven method for the production of the individual superman, but none the less the day is not far distant when in the name of posterity, if not

[1] P. xxiv.

of the kingdom of God, the State will have to step in[1] to prevent the perpetuation of undesirable strains of heredity that have been known to exist in a "pure" form for several generations. Altruism as advisedly practised is a very difficult undertaking: very easily it may do ultimate harm in excess of immediate good. "Charity," says a French writer, in a slightly different connection, "causes half the suffering she relieves; but she cannot relieve half the suffering she has caused." At present altruism tends to turn the edge of Natural Selection, but makes no corresponding control movement, with the result that it is inevitably causing an increase of the physically degenerate elements in society. We change the environment for the better, but put no check at all upon the propagation of the sociologically undesirable. A more discerning altruism will proceed to devise means of controlling the reproduction of the imbecile and organically diseased, as also of those elements that show no foresight or sense of responsibility in matters that so gravely concern the national well-being.

Its first endeavour will be to collect data, to learn where our legions of insane, feeble-minded, deaf-mutes, paupers, and criminals come from, to keep these strains of human life in their own channel, and consider how they may be checked. We have become so used to these conditions that we tend to think of them as necessary, instead of realising that the divine indulgence given to "times of ignorance" ceases when knowledge has been granted to men. It is possible to proceed along two lines: either by segregation or elimination of the unfit and undesirable, or by the direct encouragement of that which may be considered desirable. The

[1] As has already been done, amongst others, in the States of Connecticut and Indiana, U.S.A.

former alternative will preferably appeal to the eugenic mind; for while we know pretty clearly, at least in a few extreme cases, particularly of disease, what is unfit, undesirable, degenerate, it is not so easy to decide what qualities may be useful to society, or in what proportions they should be encouraged. And further, in extreme cases, as Bateson indicates,[1] "unfitness is comparatively definite in its genetic causation, and can, not unfrequently, be recognised as due to the presence of a simple genetic factor," while on the other hand the higher physical and mental capacities seem to be the resultant of numerous factors whose analysis or synthesis defies our powers.

In the case of genetic variations of such differing gravity as cataract, colour-blindness, epilepsy, and feeble-mindedness which cannot be trained into normality, an instinct of parsimony will repress any idea of attempting the hopeless task of their elimination by intermarriage with more healthy stock. On the contrary, "by discouraging imprudent marriages and absolutely barring those of persons of proved feeble-mindedness (as, indeed, is now legislatively provided for in some half-dozen of the States of the American Union), we can at least diminish the production in the future of feeble-minded children."[2] Segregation in farm or industrial colonies apart from the ordinary community commends itself to modern medical thought as the proper means of dealing with the majority of such cases, "for otherwise there is always the risk (too obvious in the experience of our maternity wards and Magdalen homes) of the production of illegitimate progeny. Experience shows that the inmates of such colonies as have been already established live happy,

[1] W. Bateson, *Mendel's Principles of Heredity*, p. 305.

[2] Dr. G. E. Shuttleworth, *Report of the Church Congress*, 1910, p. 150.

useful lives to the extent of their capacity, and although there may be need of increased legal power of detention in certain cases, the majority show no inclination to leave the tactful and loving care provided for them. But many more colonies are required, and inasmuch as the money spent on them would diminish the cost of gaols, workhouses, inebriate and other institutions into which the unprotected feeble-minded drift, society would not in the long run be as much out of pocket by the change proposed as might be anticipated." To such industrial colonies could be attached the residential schools that seem to be more and more called for in the case of the increasing numbers of children medically certified as defective and requiring special education. Previous to all such realisation, however, must be the shaping of an ideal of greater social integration, in virtue of which the present generation will become alive to its responsibility to generations yet unborn. Such an ideal must ultimately involve a spiritual conception and interpretation of Nature. For it is fact of history that where no supra-rational transcendent sanction is recognised, human nature is unable in itself to subordinate its individual temporal proclivities in the interests of future generations, and only those communities in which a definitely spiritual outlook on the world is fostered have been proved to be possessed of the elements necessary for social survival.

Heredity and Responsibility.

There remains the perennial difficulty of reconciling the apparently exclusive principles of personal responsibility and the transmissibility of qualities from parent to child. With the Weismannian denial of the transmission of acquired characters, responsibility would remain with the individual. He in large measure is

"the master of his fate." He cannot blame a previous generation for his own shortcomings, nor can he transmit his failings to posterity. Brain cells may be trained, but not germ cells, and provided the adequate environment be supplied, under its differential stimulus certain qualities are literally "led forth" or educed, while other potentialities are repressed. This would make the individual's desirable development dependent on his getting into the best environment, while it would lay upon the community the burden of seeing that the handicaps of Nature are compensated for by a superior quality of Nurture. The Weismannian doctrine is, however, far from admitting of sufficiently decisive demonstration to warrant any particular line of progress or moral education being grounded upon it, while in proportion as men come to realise the solidarity of the race any tendency to fix the responsibility elsewhere than on the individual will take the form of a growing feeling that "not a murderer is hung, not a daughter starts on her downward career, but a great company, like those who were present at the stoning of Stephen, stand by consenting to the ruin,"[1] —his immediate ancestors, perhaps, but also those who encouraged him in the development of his evil tendencies, or complacently permitted the survival of the conditions in which these tendencies flourished.

The deeper question is whether there is such a thing as personal responsibility at all, for the assertion of it involves the assumption of the freedom of the will. Yet upon this assumption society is founded; remorse, the feeling that a man might have done otherwise, seems inexplicable on any other view. An estimate of moral actions is possible only on the condition that they are the expression of a man's free will. In Science there

[1] Amory Bradford, *Heredity and Christian Problems*, p. 202.

is strictly no warrant for determinism. Her statements are all conditional. They take the general form that under such and such conditions certain results will follow: they do not state that these conditions will or must occur. It is impossible not to admit the existence of a broad area of determination in human life that is strict and mechanical, but to refuse to admit the recognition of a certain reserved plot of personality where the determination is not so fixed in expression, where a certain plasticity is recognisable, and where that creative consciousness, which is the sole dynamic reality in all phemomena, can initiate action, is to deny a statement relative to the will in name of a physical category of causation which after all is ultimately derived from the will itself.

Heredity may modify and condition responsibility: it cannot destroy or disannul it in the normal individual. A man is not necessarily responsible for the circumstance that certain possessions were bequeathed to him; but in so far as they are his possessions he is responsible for the use he makes of them. Where inheritance and heir are one the conditions are not otherwise. "Behold, all souls are mine; as the soul of the father, so also the soul of the son is mine. The soul that sinneth, *it* shall die."[1] At the same time heredity introduces shades of responsibility so subtle and delicate that the more we study men as we see them around us, the more impossible it appears for us to be able to judge any man, the more we feel that God alone can judge righteously.

[1] Ezek. xviii. 4.

CHAPTER X

ENVIRONMENT

THAN Environment, in the broadest sense of that term, no factor in Evolution is more important. Under this category we may include *e.g.* the results of the stimulation of particular food, of climate, of injury, and of use and disuse, on the assumed transmissibility of the results of whose play upon the organism the Lamarckian explanation of Evolution was based. Important in the case of the individual life-history, it is not easy, in face of the uncertainty regarding their transmissibility, to estimate their value in the racial history. Certainly in the vegetable kingdom use and disuse can have played no part. We cannot suppose that the facts of hair distribution in man are explained on the supposition that he "used" the hair of his head more than that on his anthropoid back. No organ is more used than the tongue, but there is no increment of use-inheritance. If the environment influences the individual through the germ cell, and the results are transmissible, we should expect a progressive degeneration in the case of forms inhabiting unfavourable environments. But the facts hardly bear this out. We may have a repetition in successive generations of pale-faced stuntedness in slum-bred children, but it does not progress to any such marked extent as would be the logical outcome of the acquired character theory.

Nature does not move so quickly as all that. Throughout the Middle Ages almost till modern times, the Jewish people were confined to the slums of the cities where they dwelt, but the Ghettó characteristics do not include progressive physical degeneration.

The fact that the seeming inherited effects of these aspects of environmental influence may be otherwise explained in every case adds a sense of suspicion to the too easy Lamarckian interpretation. On the other hand, there is experimental work suggesting that some measure of truth—as yet, however, incapable of clear definition—corresponds to the general belief that the individual can to some extent permanently modify its ancestral patrimony, and that the effects of the environment may under certain special conditions be, so to speak, more than skin deep. There is little unequivocal proof that a specific acquired variation is exactly reproduced in the succeeding generation by direct transmission, but this does not necessarily mean that the gain or loss of the individual is without any effect on his offspring. Darwin, in his earlier days, was inclined to treat the Lamarckian factors with scant respect. Later, his views were modified. In 1876—two years after the appearance of the second edition of *The Descent of Man*—he wrote: "In my opinion the greatest error which I have committed has been not allowing sufficient weight to the direct action of the environment, *i.e.* food, climate, etc., independently of natural selection."[1]

How much it is necessary to take the environment into account at every moment in considering the development of any form is shown, *e.g.*, by Herbst's experiments on the egg of the sea-urchin. When certain components of the salt water were replaced by other chemical substances, the structure of the larva

[1] *Life and Letters*, vol. iii. p. 159.

differed profoundly from that developed under the normal condition.[1] In fact, it is only in studying the abnormal environment and its results that we realise the persistent effect of the normal environment. The study of the living organism in its environment is the study of two variables; their interaction produces the specific results that we see. In the case of the lower organisms, this environment, wholly physical in character, almost completely determines their life. According to their obedience or disobedience in adaptation, do they survive or fail. It will appear that, ultimately, the environment, spiritually conceived, is the more enduring element, nevertheless it also changes, and although these changes are slower and not usually on so marked a scale as the changes in the organism, it can still be shown that there is a marked correlation between such change and critical moments in the evolution of life, as at the close of the Carboniferous Era, when reduction of the amount of carbon dioxide in the atmosphere by the vegetation, combined with elevation of the land surfaces, prepared the way for a new advance. To every change in the environment there is a corresponding change in the organism.

Experimental work, *e.g.* that of W. L. Tower on Chrysomelid Beetles of the genus Leptinotarsa,[2] has been conducted with a view to determining the precise relation of environmental stimuli and changes to the production of variations. Some very striking results have been reached, proving the direct influence of environmental stimuli—changes, *e.g.*, in temperature, food, light, etc.—in disturbing directly the equilibrium of germ cells, and so inducing marked variation in the next generation, while the immediate effects of the

[1] *Archiv. Entwick. Mech.* 17, 1904.

[2] Pub. No. 48, Carnegie Institution of Washington, 1907.

environment in bringing about change in the individual—those changes that are of the nature of adjustments—is the initial observation of biology. Even from the Weismannian point of view, adjustments or adaptations are effected by the selection of genetic variations. The selecting agency is none other than the environment; or more accurately, the organism is at every moment reacting to the environment—a reaction different from the passive reaction of the stone to a kick—a reaction which in the end is of the nature of life or death usually before the period of reproduction, and the final result of which, at any moment, is selection or rejection. In every way new characters depend upon the environment—both for origination and for perpetuation. How, exactly, the stimulus acts we do not know, nor can we in any degree predict the character of the variation. But that the environment causes variation in an orderly and broad-schemed manner there is no doubt. In short, the ultimate cause of variation lies in the environment, whether its action is direct or indirect.

In the case of man, we have already definitely committed ourselves to the position that environment has the last word. In his case so little depends comparatively upon the inborn capacity and so much upon the actual acquirements, that the environment means more to him than it does to any other creature. His relation to it is a growing relation. And we do well to bear in mind the importance of this factor in the individual life, always present, always varied, counting because of its constant pressure.

"There was a child went forth every day;
And the first object he looked upon, that object he became;
And that object became part of him for the day, or a certain part of the day, or for many years, or stretching cycles of years.

The early lilacs became part of this child,
And grass, and white and red morning-glories, and white and red clover, and the song of the phœbe-bird," [1] etc.

Yet already in the higher animals, and certainly in man, the influence of organism upon organism counts for more than the inorganic environment,—those subtle interactions that are the result of the web of life, like the unhappy effects produced by parasites upon their hosts, the insect galls on plants and trees, the influence of the various forms and classes of society upon its members. Here the effect of the environment is not as a rule immediate: its influence is chiefly felt in modifying the action of the individual, in stimulating, limiting, or diminishing its functional activity. Accordingly we must expand our conception of the environment beyond these three-dimensional aspects with which we usually associate it when considering it in its relation to the humbler forms of life. We must include not merely its physical but its psychical aspects. There is no doubt that in addition to relations with the inorganic aspects of the environment the members of early protozoan colonial forms were in direct or indirect physical contact with one another by connecting filaments (*e.g.* linin elements of the reticulum)[2] or otherwise, by which means not merely were greater unity and compactness of social life brought about as the response made by individual members to particular stimuli was communicated to other members, but the condition of some members exerted a direct influence upon others. In some such way does the individual cell in all higher organisms become aware of the responses to environmental tendencies and stimuli given by other cells until centralisation and unity of response result. The process of co-ordinating

[1] Walt Whitman, "Assimilations."

[2] Cf. pp. 81, 100.

and centralising the differing reports on the environment made by the units of an organic colonial form is strictly paralleled by the development in the central nervous system. When we reach the stage of man, while this direct physical contact normally ceases, nothing is more clear or strong than the environmental influence of his fellows. It may appear with the physical element strongly marked, as in the mutual effect upon one another of mother and child, although even here the influence is disparate—the desire of the child for its mother being more physical than psychical, that of the mother for the child more psychical than physical;[1] but we quickly reach cases where, although doubtless there still is nervous stimulation, the principal activity seems to be in another dimension, so to speak, and the influence of mind upon mind or feeling upon feeling may be exerted altogether apart from sight or sound or touch. This psychical zone of the environment means more to man than any other. The communication between its elements has usually been considered to be indirect in character, as by signs and gestures, and in close relation with physical phenomena; but it appears increasingly probable that the psychical impulses or contacts may be also direct (telepathic).

Of the reality of this subtler psychical aspect of the environment no man can have any doubt. As the result of its stimuli the individual mind develops, the individual's feelings are awakened. It is true that in this zone the three-dimensional tests are unavailing,—we cannot calculate the horse-power of hate nor take the specific gravity of love,—yet our perceptions of the psychical and of the physical zones are ultimately alike in being states of consciousness, affections of some discerning principle associated with the central

[1] Cf. H. M. Bernard, *Some Neglected Factors in Evolution*, p. 390.

nervous system. With the five senses man is magnificently equipped for his exploration of the physical zone of the environment, and for this psychical zone—where in our perfect development "we shall know even as we are known"—man seems to be equipped as a definitely spiritual personality, whose evolution is only really now beginning. Concerning the relation to the body of the percipient integrating controlling spirit that is something more than the sum of his powers of perception into the physical and psychical forces of the environment, various views have been held. Without examining them we may consider the genetic character of this "spirit" and its relation to the environment.

We have seen that the fundamental similarities in racial, national, even occupational mental character point to the basal rôle of heredity: further, the inexpressibly slow rate of evolution is only to be accounted for on the same understanding. Tremendously conditioned by physical heredity yet responsive to the traditional psychical environment, the individual moves along in the racial stream of human life. Yet is there concealed within the body an integrating controlling selfhood that leaps into activity when touched by the spiritual in the environment. In the course of the interchange a stage is reached when it may acquire a stability that outlasts the shock of death.[1] Change in the physical environment will undoubtedly help to set up change in the physical part of the organism. This physical dress certainly is handed on in direct continuity from one generation to another; but the *node*, the specific spiritual centre of combination of the elements of personality is only developed at self-consciousness, and is thereafter persistent in a greater degree

[1] Cf. pp. 374, 375.

than any element that it combines. Its constituents are largely, perhaps all, hereditary, but the particular collocation—that cream that rises to the top out of them all, that extract or essence in itself—is not a hereditary thing. It is a unique creation; it is not a duplicate; it is a living soul. The physical stream shows continuity, but those individualities that rise out of it are not in genetic relation. The higher we rise in the scale of mentality, the wider the range of individuality, until in the human race we find its greatest scope; but even within the range of human life we find immense variety and distinctiveness that mean more in life and action than the common basal heredity. The lower ranges of mentality doubtless are subject to hereditary transmission, as we have seen:[1] we are aware of primary instincts and feelings, mental associations, and specific responses that are common to men and reappear generation after generation, thus suggesting definite transmission. Nevertheless, there remains that which is not within the process in quite the same sense as the rest, for it comprehends the process and is akin to that which is at the core of it all. This conception of spiritual personality, as that which controls those lower ranges, and is something distinctive and originative in action and thought—a kind of receiver and transmitter in one, a coherer in short—does not fit itself into the ordinary ideas of hereditary mechanics. Consciousness, particularly in its highest sweep of self-consciousness, is not something that is explicable in terms of any simpler antecedents merely: it is unintelligible apart from the larger consciousness that finds a partial expression in the less, and in varying degrees in other phenomena of Nature. It pervades the environment, and out of that works itself

[1] Cf. p. 216.

into the being of the lesser expressions of it. It is because personalities crystallise out of this great stream of human life that it behoves us to do what we can towards its eugenic improvement. The naturalistic and the religious view, each of them, expresses a truth, and it is no help sharply to oppose them. Certainly man is, rather than has, a soul; and once he has reached the level of self-consciousness he is able through his spirit to come into communion with that Spirit that informs the whole process of which he is but a part. He is of it, and yet not of it: for a period, his incubation period as it were, the environment acts as his nurse in its purely physical and proximate aspects, but a stage comes when he is able to penetrate past that which is proximate and immediate to the deeper Reality in which everything consists.

How, then, shall we ultimately think of the environment? In its widest sense we may apply the term to everything that is external to the living being. But it is only the informing energies there that actively affect it. We have already realised how any particular stage of development is the resultant of the effect of the environment upon the preceding stage of the organism. Now, this in its proximate physical aspects is very simple for the simple forms of life. The protozoon is in minimal correspondence with its environment. Not merely is its range of activity very limited spatially, temporally, and in diversity but the isolation of its life in relation to its fellows is almost complete. The protozoon and the fish are literally in the same environment, yet how different the environment is to the fish by reason of its wider range of commerce. Its eye involves a greater acquaintance with the environment than can be gained by the diffuse

phototactism of the protozoon. As life advances, the successively higher forms come into deeper correspondence with an increasing number of elements in the environment. Evolution essentially involves the progressive development of the means of adjustment of the organism to the environment. The criterion of advance is the scale of correspondence with the environment: in that lies fulness of life. Evolution is not merely an unfolding from within; it is an infolding from without.[1] And that which is taken in at one stage, energising within the individual, prepares it for a yet wider, more subtle, and more intimate relation with the environment. The higher the form, the greater and more complete is its correspondence both extensively and intensively with the environment. In man, with his highly specialised nervous system so co-ordinated as to enable him to compass the environment and control aspects of it in a way that is unique amongst organisms, we see this correspondence marvellously developed, yet we have realised how poor is even the best human correspondence. The progressive evolution of the eye may be traced through various stages from *Paramecium* with its diffuse, positive phototactism, through *Euglena* with its eye-spot, up to the well-developed vertebrate eye, with its fine capacities for appreciating form and colour. Light was there, however, all the time, though but dimly perceived by the lowest forms. Not otherwise could living organisms have become aware of and responded to the light demands of their environment by the formation of an eye. Even in the development of this single sense there has been a growth in the range of experience, each stage marked by illusions which

[1] Cf. H. Drummond, *The Ascent of Man*, p. 414.

were corrected by further advance, each stage conceivably characterised by a certain agnosticism with regard to any subsequent stage. "New organs do not develop unless there is a function for them to discharge connected with a correlated external condition."[1] It is from the environment that the inflow and outcall originate, and each new relationship between the progressing organism and the environment makes that same old environment something different and new. When we consider the racial history we may even notice a grading in the different dominant types that were successively produced as the resultant of its action—a definite character in the successive conformities that meant survival,—powers of assimilation, muscle, then cleverness (mental ability), unselfishness and social virtue, spirituality,—until finally the environment in its deepest most spiritual aspect seems to take the guise of "a power not ourselves making for righteousness." Now, in the case of the ear, we can trace its relationship to different elements (water in the case of fishes, air in the case of terrestrial forms) in response to whose vibrations it has developed. In like manner there is a distinctive adaptation of the tongue, nose, and fingers to material aspects of the environment. But all our knowledge of these elements will not help us when we strive to understand the eye. Accordingly we must seek another element—the ether, subtler far than those under whose influence the other senses were evolved—before we unravel the correspondence here, and we become aware of the ethereal environment which, mayhap, is not discontinuous with the environment of material things, and through which a man gains a new view of the cosmos. Interpreting the environment in terms of the ether means some-

[1] Prof. A. Macalister, *Expositor*, January 1910.

thing more generalised and profound. Yet life and thought itself in the citadel of this outreaching being are not explained by reference to the material environment or the ethereal undulations. Light is not explicable by the material environment alone: still less can life and thought be interpreted by the material and ethereal environments alone. The grossly material environment does not exhaust man's possibilities: he evidently responds to or is influenced by something more than the things he touches, tastes, and smells. Even his sense of sight is not concerned alone with matter, ordinarily conceived. So we are fain to believe that in the environment must be some other element, "met-ethereal," akin to thought and righteousness, akin to that which it has persistently produced of lofty moral and religious idealism in the noblest of men, akin to those characters that it has progressively demanded in living beings as the condition of survival. At any rate, we cannot conceive of the environment as merely mechanical and material. There must be that which is spiritual and righteous about it. Indeed, in its most intimate and ultimate manifestation, shall we call the environment "it" or "Him"? Can there be anything less or lower in the cause than there is in the effect? Have we not here to do with Him in whom we live and move and have our being?

For, when finally we consider that man *is* a religious animal, we find it difficult to believe that there is nothing in the environment that elicits that particular characteristic. Has not the human mind since the beginning been aware of some larger yet subtler spiritual character in the environment than that which is merely found in the psychical zone of his fellows' minds? How else shall we explain those potentialities

in every man, wrought into the fibre of the race through its past experience, initially developing now, like the elements of the embryonic eye, no longer under the original stimulus, yet able to respond to it directly they are placed under its influence? As little can we believe that the eye was developed without the play of the ether waves as that the religious faculty was developed without thrills and pulses of some corresponding Reality in the environment. Perhaps the Cœlenterate hydra, if self-conscious, would have worshipped a glorified stomach, and the worm a glorified muscular force [1] (and some men still hold such objects of worship in reverence, but they are human reversions). We must judge by the highest and the best. Nor does it follow that as in the growing revelation even higher features are later discerned in the environment, those that are earlier or lower absolutely disappear. The son of a king may know his father first as love and kindness, and later realise that he is a statesman, and a king all-wise and powerful, yet does not cease to think of him as love and tenderness. Henceforward, however, man's development will be spiritual, and so we are compelled to believe in a spiritual cause in the environment that was aware of an end from the beginning, towards which it has all along been working. Man's further progress depends on conformity to this spiritual environment, *i.e.* in becoming like it, and he can consciously conform. The interplay, the unfolding and infolding, are there all along: by mutual reaction each is strengthened. But conformity to what is deepest and best, conformity to those realities that are unseen and eternal, means nonconformity to some of

[1] Cf. J. M. Tyler, *The Whence and the Whither of Man*, p. 160, from whose pages much assistance in the presentation in this paragraph has been derived.

the lower, more palpable and proximate elements of the environment. It means, in addition, conformity or obedience to the laws of the individual's innermost structure and higher being. It involves deliberate surrender to the influences of the spiritual environment, that mutual interaction of the human mind with the eternal Mind under which arise those visions of ideals yet to be achieved, ideals of social and individual worth, the ideal of the kingdom of God. By reflection on these the individual under the evolutionary influence of the informing Spirit becomes "persuaded" of them, and his life becomes a life of devotion to them until in it they become luminous to his fellow-men. Inevitably through the inertia of the material, and the self-absorption of the present, their realisation will be pushed out into the future. But these are the men who are holding and shaping the future, while those of the bounded horizon, who are engrossed with the present, completely adapting themselves to it, must perish with it. To walk by sight conforming to the palpable is superficiality of life. Even that cannot be done without faith, only the man is not aware of it in his spiritually unconscious existence. He only is alive who lives consciously by faith, a faith that holds the future just as surely as it understands the present. Paul states the law, "Be not conformed to this world; but be ye transformed (*μεταμορφοῦσθε*) by the renewing of your mind, that ye may prove what is that good, and acceptable, and perfect will of God."[1] Within limits the law holds true for the lower creation; it was the rule of progress even in the Silurian days. The mollusc conformed to the most obvious and proximate elements in its environment, and progress ceased for it. It lived a life of ease: food there was for it in

[1] Rom. xii. 2.

plenty in the slime, and in assimilation and reproduction its whole life consisted. But the ancestral vertebrate, forced into an active swimming life because of the competition with the gigantic shell-clad Orthoceras, conformed in another way, and was transformed, lit. metamorphosed, into something higher.[1] A certain measure of conformity is necessary to secure that survival without which there can be no possibility of progress; yet the persistent temptation is to conform so completely to the proximate elements of the momentary environment that there is no possibility of permanent survival, still less of advance. It is admitted that the unmasking of this ultimate Environment is very gradual, that even yet man is not fully aware of God, cannot comprehend Him in His infinity. In this direction, however, it seems perfectly clear that the further evolution of man must take place if he is to progress, for he is most sharply distinguished from the forms immediately below him by his moral and religious characteristics, and they are most highly developed amongst the most civilised peoples. True, that progress is very slow, and the great majority of men are not even aware of its direction, being content with conformity merely to the physical elements in the environment. But as the sensitive photographic plate, steadily and long exposed, reveals what human eye has never seen, even with the telescope, of the farthest and deepest heaven, so in the human soul set steadily towards the spiritual environment, will there, eventually, be mirrored something in revelation of the personal God so dimly seen in the immediate physical environment. Or, best of all, in the face of Jesus Christ, whose correspondence with God was perfect, and in whose mind were

[1] J. M. Tyler, *op. cit.* p. 200.

focused the rays of spiritual truth from our spiritual Environment that have become a revelation to man, shall we see the clearest reflection of the Divine Glory. To dwell in such complete and perfect correspondence as was His with the Supreme Environment, which is God,—that is heaven.

CHAPTER XI

THE DIRECTIVE FACTOR IN EVOLUTION

OF the world process as a whole, it will be agreed that our finite minds with their limited ancillary appliances can form no adequate conception. Quite apart from all ideas of development, the modern account of the proper motion of the stars, for example, raises the question of direction in a bewildering way. In an epoch-making paper on star-streaming,[1] Kapteyn gives evidence for believing that two apparent directions of motion predominate in the stellar world, and that the two star-streams which comprise the stellar universe as known to us, must be moving in diametrically opposite directions. He adds: "In order to prevent misconception, however, it will be well to state expressly that the existence of two main stream-lines does not imply that the real motions of the stars are all exclusively directed to either of the two vertices (*i.e.* the points of the sphere towards which the star-streams seem to be directed); there is only a decided *preference* for these directions. . . . *All* the stars, without exception, belong to one of the two streams."

The fact of these two apparently aimless star-drifts moving past one another in opposite directions through

[1] *Brit. Assoc. Report*, 1905, p. 257. Subsequent confirmation has been given by Eddington and Dyson.

space has already been seized on as evidence of the purposelessness of the universe. So also might a mayfly released one sunny Saturday afternoon from the prison of its lower life in the quiet of a canal hard by some city notice two streams of human beings passing in opposite directions along the two banks, the one from the country into the city, empty-handed yet pensive, to purchase their week-end needs, the other passing from the city, buoyant though heavily laden, to picnic in the fields. And if towards the close of the day, as the mayfly's life ebbed with the withdrawal of the sun's rays, it noticed a reversal in these movements, as the country-people laden with their stores moved out again with gladness towards their homes, while the townspeople, their outing ended, moved unburdened yet subdued towards the city again, its philosophy of human existence might well be that though there was a certain background of permanent stability, yet life consisted in drifts in two opposite directions which after a time slowed down, ceased, and then recommenced in the reverse directions, accompanied by a certain redistribution of matter and apparent change of energy. What could the mayfly learn of human purpose? Brief as the love-dance of the mayfly in the sun is the life of man compared with the process of the ages: the human ephemerid is aware of movement, redistribution of matter, and transformation of energy, and too often he writes it down as aimless and purposeless. Much current philosophy is on a par with the mayfly's.

However we may seek to decide the issue as to direction, it must to-day take its place in an evolutionary scheme. This at once prevents us going out into the world there to gather ready-made proofs of divinity: rather does it show us a world that is be-

coming divine. Between the watch and the flower[1] there is this further enormous difference that, while the former is so little in itself—so easily compassed in understanding in its entirety—that the Paleyan mind goes off in speculative questioning about the maker, the latter is so inexhaustible that inquiry takes the form, What is it? But to answer this, as Tennyson rightly perceived, is to understand all about not merely the flower, but the Whole to which it is related. Not merely the watch and the stone but the baneful insect under the stone, and the thief who dropped the stolen watch as he ran, would all have had to be examined in the same narrow way, with varying result. This Paleyan method of calling isolated witness could never demonstrate Paley's preconceived God unless with careful selection of the witnesses. The vital question is, What are the character and testimony of the Whole? To ask this question is, however, to rescue the conception of design from the stiff, calculating, carpenter-like method of the Paleyan mind; it is to surrender the conception of a predetermined programme of creation, every detail of which is knowable in advance and specifically planned, and to substitute in its place the thought of an energising Principle which works persistently and reasonably, yet spontaneously, and which gradually realises an aim whose tendency is, at any rate in part, perceptible to finite minds. The older conception still remains with us in part, because human life exists under the conditions of a time process, but it is inapplicable to a God whose creative activity is continuous and timeless.

With regard to the cosmic process as a whole, then, we cannot agree with any certainty. How could we indicate purpose in the heavens? They bear the

[1] See p. 127.

marks of intelligence, but we may well believe that the purpose is too great for us to understand. Perhaps the modern study of astronomy shows us more and more of intelligence, and less and less of purpose such as we can yet comprehend. When we consider the heat and light radiating from our sun in such endless profusion to all points of the universal compass, our finite minds tend to ask, To what purpose is this waste? The Mosaic cosmology tells how God "made the two great lights; the greater light to rule the day, and the lesser light to rule the night," but at that point the sacred writer's perception of a purpose seems to halt, and he simply adds, "He made the stars also."[1] Accordingly we shall limit the inquiry for the present to the realm of the organic and the inorganic as we know them on that planet which if not *the* centre of the universe is at any rate *our* centre, whose history is our history. What is true of the part may not be true of the whole, but it is something to be sure of the character of the part that we do know. The question is whether the process as we know it betrays purpose, guidance, direction?

So far as the denial of this is sometimes indirectly based on the supposed findings of scientific research, it is not merely necessary to realise that her account of phenomena is not merely an incomplete account, but that the strictly scientific account often contains implicit within it more than the expositor realised or even in some cases intended or desired: indeed, in these respects he is often hoist with his own petard. For example, if we consider for a moment the famous

[1] Gen. i. 16. It is perhaps only fair to state that the Old Testament critic considers the words "He made the stars also" to be a gloss (cf. Skinner, *Commentary on Genesis, in loc.*),—which illustrates the difficulties of Biblical interpretation.

Spencerian formula, "Evolution is a passage of matter from an indefinite incoherent homogeneity . . . to a definite coherent heterogeneity," not merely do we never get any actual passage or specification [1] under it, but even as we think the sequence of stages of this passage backward in their causal relationship we never reach a stage that is strictly indefinite, as *ex hypothesi* it is sufficiently definite to act as cause to its immediate successor. Further, we never actually get a hint of a homogeneity out of which, even if it did exist, no heterogeneity could arise. The constitution of the all-comprising nebula at any given moment—to take a favourite Spencerian illustration from the inorganic realm—must have been just as specific and definitely organised as any of the later and more complex phenomena resulting from its transformation and differentiation. To Spencer's mind, matter wherever it exists in a homogeneous mass, *e.g.* the primal nebula, is of necessity unstable and cannot remain homogeneous. As a matter of fact, inasmuch as we are unaware of matter except in so far as it is allied with energy—the modern physicist interprets one in terms of the other—this primal homogeneity of constitution and relationship is a mere figment of the imagination. In fact, Spencer admits that at whatever point we choose to think of evolution as commencing, that change was necessitated by what went before, and there "remains to be added the conclusion that these changes (thus initiated) must *continue*." [2] Or, in other words, evolution itself is determined by some preceding definite heterogeneity, and all that is developed at any stage was implicit in the preceding stage. But this leaves

[1] Such *e.g.* as you get in connection with every building under the law of gravitation.

[2] *First Principles*, p. 429.

us with the question, which is indeed there at every stage, To what is due that particular heterogeneity, that definite arrangement of matter and energy that at any stage contains implicit within it all that follows? This question Spencer never answers.

What, then, is offered to us in the name of much modern philosophy of science is a series apparently now, *sub specie eternitatis*, interminable, *a*, *b*, *c*, *d*, . . . in which we come to think of *a* as the cause of *b*, of *b* as giving rise to *c*, and so on. Strictly, however, we do not know that *b* will follow *a* in any particular case: we only believe it. And, further, the deduction so frequently made that all that is in *b* is implicit in *a* and so on, is simply untrue in the case of the developing organism if we consider the letters as representing successive stages in its ontogeny, for at every moment that development is in vital dependence on the environment. In short, there is much misuse of the word "cause." Physical cause differs from efficient cause. Into the conception of scientific cause enters only the idea that things affect one another in definite ways. In a true cause we find an element of volition, and in all creation this is the principal element. Nothing, then, of volition enters into natural law *per se*, although in the objective world natural law might be held to be a true cause, volition always being excluded. But then in human life volition is the only true cause. We may learn perfectly the order of changes, and yet learn nothing as to why they occur in that particular order. The infinite regress affords no resting-place for the tired mind: it wants to know the character of the creative energy that it perceives to be at work in the world process. Looking, however, at the series in its most general form, what we have to determine is whether the

particular form that the series takes is a matter of chance or of definite direction.

That it is matter of chance, as the answer given *e.g.* by the Haeckelian-Spencerian school, does not bear careful examination. The indefinite tossing of a coin by the unconsciously adjusting and compensating human hand may in accordance with theory result in an equal number of heads and tails: thrown by an accurate constant machine, the coin may be compelled to manifest its bias, and it is possible that the succession might be tails *ad infinitum.* All linear series of phenomena, in space of one dimension as it were, are from this point of view mechanical, causal, and sequential: the element of chance is ruled out. Any interplay or striking result arising from the impinging of horizontal series in space of two dimensions as it were, is a coincidence and due to chance. In 1871 two companies of men began tunnelling towards one another on either side of the St. Gothard Pass: ten years later they met. In terms of this philosophy the linear drills were mechanical and causal: the fact that they met was chance. Here, of course, the cause is found ultimately in the mind of the planning and directing engineer: the question is why it should be otherwise in the case of these convergences in Nature that at least wear the guise of ends. On examination, at any rate, it becomes clear that chance in Nature and in pitch and toss, in the life of the animal and of the spirit, does not really exist as such, but is simply a word used to describe that of which the causes are not known to the observer in their entirety: it can never amount to saying that they were not due to purpose,—in fact, it includes that possibility.

Science, then, offers us her account of the world

process in complex series of sequences, but if we are to be certain in our deductions as to what lies behind the process, if we are to trace backwards each step systematically until we come to that which we may think determined the process, if we are to be effective in our examination of its purposefulness or otherwise, we shall have to be very sure that we are investigating the whole of the process. If Science can argue back from what is to what has been, and venture to predict what will be from what is, it is essential that she understand fully and completely what is. And it is just here that the doubt is greatest as to her success, and often in direct proportion to the incompleteness of her account is a certain studied disregard and contempt—in itself so contrary to the true scientific spirit—for anything that cannot be fitted into the network of relations and uniformities as known at any definite period in history, as also for any suggestion of implications of a wider nature than those which the surface view of the data affords. It is essential that Science understand fully and completely what is. If any attempt be made *e.g.* at elucidating the evolution of morality or the causes that produce it, then that account must not commence with the morality of the bushmen, but with morality as we know it at its highest and best. Working backwards, the investigating mind will never discover a stage in which there was not active determination and specification, pattern and power. The scientific mind may break in at any moment with a formula, and state that under certain conditions in terms of that formula the whole world process can be explained. One thing the formula cannot do, viz., explain itself.

If now we consider the question on its positive side, we find our initial reason for believing in the

existence of a World Principle in the simple fact of the unity and intelligibility of the universe. The proof of the unity of the World Principle must start from a system. The universe, we maintain, is such a system. Every thing is what it is, in part because things are as they are in other places. We deduce this by reason: it is not a matter of experience. Science posits a dynamic relation between things. Things determine one another; they interact; we find a law of uniformity of action. These facts make the world an object of knowledge: Nature as a system is a cognitive ideal. And yet the whole creative arch was not sprung at once. Consequently, if one of the elements of the solar system should disappear, it would not mean the collapse of the system. If the moon should disappear, perhaps the tides would be less, the days shorter, the nights darker; otherwise there would be adjustment,—an indication of essential unity. That the intelligibility of the universe is partial only is nothing to the point; the mere fact that the world process whether in detail or as a whole is susceptible of being understood, however imperfectly, seems resoluble only in one of three ways. We may suppose that this intelligibility is a chance accompaniment, a sort of epiphenomenon, of what is *ex hypothesi* a non-rational process: to believe this involves an irrational reversal of all experience. Again, we may maintain, as has often been done, that the intelligibility and so the rationality that man finds in the world process are simply the projection of his own reason into it. I do not know if a lunatic's philosophy would interpret the world process as chaotic—a reflection of his disordered mind; if so, it might be difficult to differentiate between the diagnosed lunatic and him who professes to find no objective order in the world process as

a whole. It may be perfectly true that our minds have to some extent adapted themselves to this universe, and that on such adaptation depends human existence, yet we have the idea of unreason, and we can realise that self-conscious life would not be possible in a universe that was unintelligible to us. Finally, we may maintain that the universe is intelligible to us simply because behind and within its phenomenal activity there is something akin to the human mind. To the casual customer the ceaseless vagaries of the telegraphic needle convey no meaning, representing merely "sound and fury signifying nothing," but to the operator they are burdened with significance; yet the moving index reveals even to him no image of his fellow-worker at the other end. It simply indicates his mind, and the message is intelligible just because it is an expression of a mind, and the intelligibility implies some sort of a relation between the minds at either end of the wire. The analogy is remote, for after all the telegraphic apparatus is but a static vehicle of energy. Still the phenomena of Nature, symbols significant of something which we cannot fully understand with our limited senses, and impotent to give us any measurably complete account of the World Principle itself, are interpretable just because there is this element of Intelligence in it, which has been and is related to our intelligence. In other words, Infinite Mind exists and is related to our mind.

When, further, we inquire into the character of that intelligibility, we find that it takes the form of Order. We note the qualitative and quantitative adjustment of all things according to law. The ordinances of the world stand fast; the power that supports it, of which it is an expression, shows no variableness, neither

shadow that is cast by turning. This sustained order, the fact that the process is intelligible *all along*, seems to involve the conclusion that its continuous meaning must be meant. A momentary intelligibility might not necessarily have implied a creative mind. It is not inconceivable that the indefinitely repeated mechanical sorting of millions of alphabetical letters might sometime produce that particular arrangement of letters and words which men would recognise as *Paracelsus*, but the next arrangement would be complete chaos, and even if, by the ultimate chance, it were not, and *The Pickwick Papers* instead fell out, yet the lack of relationship between it and succeeding and even preceding results would foil all understanding. Chance is incapable of producing continuity; sustained order is an index of Reason. If the order of Nature which we do find does not involve the existence of God, the disorder which we do not find would have amply disproved the hypothesis.

In any case, the explanation of Nature, even as an unconsciously working mechanism arbitrary and blind in its groping, is very difficult in face of the fact that it has produced self-consciousness and intelligence in man,—the mirror in which she in a sense can regard herself. Either we must admit that the scientific examination of the origin of the human reason results in postulating an irrational cause for it—as it might be supposed to do on reduction of that reason to a dance of atoms—and there we leave the problem, committing ourselves, however, to a gigantic act of faith in assuming the trustworthiness of the scientific reason, and too apt to forget that we are reaching these very conclusions by the self-same faculty of postulated irrational origin; or we must investigate more deeply, seeking the cause of whatever sequences

we find—even if they apparently result in the production of the rational from the non-rational—in some rational World Principle whose operations take for us the form of natural laws. The one faculty, we repeat, by which alone man judges natural process was derived in the course of the working of that process, and yet it is maintained that the process shows nothing that is akin to mind, intelligence, or reason in it. This cannot be asserted in so far as it means that the process is less than rational; in so far as it may be taken to mean that the process is informed by some Principle displaying intelligence vastly superior to the human mind, we come within hailing distance of theistic interpretation.

With the strictly teleological aspect, fresh considerations arise. Particularly in the organic world do we find to a striking degree what appear to be instances of anticipatory adaptation. Indeed, adaptability itself almost seems indicative of purpose. In the case of individual development there is not merely suggestion of the past, as in the stranded "erratic" on the mountain-side, but anticipation of the future. Where such adaptation is lacking, and mere causal physico-chemical sequences take place in their own narrowly predictable manner, we know that the organism is dead. In the case of organic bodies we see a process pointing to future results,—a prophecy of the future, at least an appearance of design. We are not deceived by the crystal; we know how it works and grows, so that this hint of design is not a mere anthropomorphism. In the case of the alum crystals there is no prophecy, simply a present realisation of a present force.

That such a contingency is recognised even by the biologist may be gleaned from his continual references to what is sometimes technically called

orthogenesis. The term is used to express the apparent initial predetermination of lines of variation apart from natural selection, which makes an ever-growing appeal to the biological mind, and to the palæontologists in particular. It occurs in all degrees, abintrally and abextrally, from Korschinsky's statement that "in order to explain the origin of higher forms out of lower it is necessary to assume in the organism a special tendency towards progress,"[1] to Eimer's sounder views that "variation everywhere takes place in quite definite directions which are few in number," and that "the causes which lead to the formation of new characters in organisms, and in the last result to their evolution, consist essentially in the chemico-physiological interaction between the material composition of the body and external influences."[2]

Of positive evidence of orthogenesis in ontogeny reference may be made to a paper by Bashford Dean,[3] in which he states his belief that the adaptation between the embryo and its egg-case in Chimæra can only be explained on the basis of determinate modification. The substance of the capsule or egg-case, although "only indirectly connected with the egg, *i.e.*, as a secretion formed by the parent after the mechanism of heredity has already been established in the egg, nevertheless (1) 'foresees' with startling exactness the size and shape of the young fish when many months hence it comes to hatch out, and (2) it provides a series of progressive modifications adapted to the developing physiological needs of the young.

[1] "Heterogenesis and Evolution," *Naturwiss. Wochenschrift*, vol. xiv. pp. 273–278, 1899.

[2] *Organic Evolution*, p. 4.

[3] "Evolution in a Determinate Line, as illustrated by the Egg-Cases of Chimæroid Fishes," *Biol. Bull.* vol. vii. pp. 105–112.

It is evident, accordingly, that if natural selection be adduced to explain the present phenomena, it encounters difficulties more numerous and complex than in usual instances. In the latter cases selection concerns itself with variations which affect the progeny directly; but in the present case variations must have occurred in the lines *both* of the progeny and, indirectly, of its far less individual capsule-forming capabilities—with the result that a succession of closely correlated stages in variation must have coincided in both distinct directions."

From the phylogenetic viewpoint similar conclusions are drawn by workers in very different departments. Thus Sir E. Ray Lankester is impelled to state that "the conclusion that man is a part of Nature is by no means equivalent to asserting that he has originated by 'blind chance'; it is in fact a specific assertion that he is the predestined outcome of an orderly—and to a large extent perceptible—mechanism."[1] H. F. Osborn, in an Essay on Darwin and Palæontology,[2] maintains that the evidence from palæontology "replaces the law of chance by another law, namely, that as in the domain of inorganic nature, so in the domain of organic nature *fortuity is wanting*, and the fit originates in many hard parts of the body through laws which are in the main similar to growth —laws the modes of which we see and measure, the causes of which we do not and may never understand, but nevertheless laws and not fortuities or chance happenings." Finally, Dr. A. Smith Woodward in his presidential address to the Geological Section of the British Association[3] makes this suggestive admission:

[1] *The Kingdom of Man*, p. 9.

[2] *Fifty Years of Darwinism*, p. 225. Italics in original.

[3] *B.A. Report for 1909*, p. 463.

"Amongst these general features which have been made clear by the latest systematic researches, I wish especially to emphasise the interest and significance of the persistent progress of life to a higher plane, which we observe during the successive geological periods. For I think palæontologists are now generally agreed that there is some principle underlying this progress much more fundamental than chance-variation or response to environment, however much these phenomena may have contributed to certain minor adaptations." Such statements, when considered in the light of the insufficiency of other factors to account for the facts, suggest recognition of what at at any rate looks like direction.

The essential element, then, in the individual and racial series alike is the prophetic hint, the co-operant travail, the concurrent conditions, the convergence seemingly towards an end. Even under the frankly utilitarian explanation offered in natural selection, the question inevitably arises in each case, Utility for what? Why does the crustacean cast its carapace? Adaptation, wonderful in itself so far as present conditions are concerned, becomes deeply significant when expressed, *e.g.*, in the reproductive parts of organisms. The question becomes peculiarly insistent in face of the fact of variation occurring in a process capable of using it for a progressive growth. It is only intellect in some form that prepares for the future; mechanism acts only in the present. We may realise that phenomena come under law; perhaps we may even find in the implications of the fact of law a partial explanation of the phenomena. But certainly we are not entitled to deny the presence of design simply because we see that phenomena come under law. How is a thing done? and, What does it mean?

are two very different questions. We can say about everything: It is law; yet if there are final causes there must be efficient causes, and the latter imply purpose—purpose which is not an element in the causal series but represents the particular combination of the elements. Now, in the case of every activity that we actually know to express purpose, we can also trace law and mechanism in it. Accordingly, when we find law and mechanism on a great scale with progressive results which look as if purpose were in them, the fact of the presence of law and mechanism cannot exclude the conception of purpose; in fact, the probability is all the other way.

That the slowness of the convergence may obscure the end so that we may even fail to appreciate the possibility of an "increasing purpose" is not remarkable. We miss the end sometimes because our eyes are riveted on some single feature that does not harmonise with our preconceived ideas. As we wander through the woods in the after-coolness of a thunderstorm, we pause abruptly before an isolated record of its trail and ask ourselves, Why did the lightning destroy that little tree? We limit our conception of the energy at work to that particular instance, forgetting that the power that designs a cell is not exhausted in the cell, and is making an infinite number of other cells. The one thing we are looking at is not the whole product of the Infinite Energy; it is acting elsewhere at the same time. And yet we are not wholly satisfied. Might it not all have been done some other way? How do we know that things could have been done in some other, *e.g.* some shorter, way? Time, at any rate, in itself, does nothing. It is not time that makes our hair grey. Change does not take time; it makes time. The only efficiency is the agency ex-

pressing itself in phenomena. Time assuredly does not derogate from purpose.

We may agree, then, that if the world process had been due to chance, we might have had other possibilities of development, yet we have but one way, and that so wonderful that at various points it seems to us as if it had been designed. To this it may be replied that the fact that the World Principle acts as if it had plans and purposes does not prove that it really has them. But as Professor Borden Bowne clearly brings out,[1] in reality all objective knowledge is ultimately based on an "as if." We do not know that the sedimentary rocks are deposited under water, but only that they look "as if" they had been. We know that our fellow-beings have minds only because they act "as if" they had them, *i.e.* because their actions indicate order and purpose. "In short, the argument for objective intelligence is the same whether for man, animals, or God,"[2] and it is equally good for all. The surmise that Nature mimics purpose is but a play upon our ignorance,—a play, however, that does not deceive us when we come to deal with ourselves. The great mass of men are conscious of themselves as agents of purposive action in a universe that responds to their intercourse with it, and of which they are an integral part, and believe themselves to be rational simply because they are in continual relation to a rationally constituted and conducted cosmos. In this world which is not a multiverse, but a universe, shot through and through with the same basal principles, erected throughout on the same broad foundation lines, we may be sure that what appears to us as purpose in the realms below that of humanity, if not the expression of the elements of these particular orders, is yet the

[1] *Theism*, p. 110. [2] *Op. cit.* p. 112.

expression of a will, a freewill that is behind and in them all.

And these considerations touch the heart of our argument. For we realise, in the first place, that we have minds, and that we are a part, products of the universe, so that in some way mind is related to the universe. At a certain stage in the onward sweep of this vast process, mind draws into organic being; as a result, there is greater adaptation on the part of the mind-informed individual. But the process itself must be something greater than this which appears as an aspect of it, even if in that aspect it becomes conscious, so to speak, of itself. Further, that universe is a unity, and it is therefore improbable that that larger part of it which we do not see or know stands in any essential contradiction to that part which we do see and know. Man certainly is capable of directive action upon matter, yet he is not independent of it. Man, the growing point of progressive life, is conscious of directive control. Spirit has had from the beginning some constant and natural relation to matter. It is there and at work. It and matter may be merely two aspects of the same thing, but it is there, directing and controlling as we know it directs and controls in the case most completely known to us—the human personality. So far as we grasp the fact that we are a part of Nature,—thus abolishing the convenient though false distinction between artificial and natural, inasmuch as all the works of man are natural works,—so much the easier will it be for us to realise the possibility of spiritual and directive control in the world not merely of life, but in the realm of matter. Reduce everything, if it be possible, to the physico-chemical level: in association with these elements spirit has at a certain level appeared—the human spirit in particular,

which in all its achievements is purposive. We are aware of purpose in ourselves. We are conscious of being influenced by ideals that are borne in on us, in virtue of which we strive and sacrifice. Sometimes we feel ourselves as instruments in the hands of a power "not ourselves, which makes for righteousness." Righteousness, at any rate, is made: and as we realise the full dramatic sweep of the evolutionary process from its beginnings to the ideals that dominate the minds that are noblest, it is not easy to say that all this has merely fallen out.

When we look back and see the stages by which the earth was better fitted to serve as the environment for life, when we become aware of the various phases in the evolution of life as characterised by higher and higher individuation, with continual increase of significance and apparent movement towards an end, when we ask ourselves why the surviving species, being the only ones that could survive under the very definite conditions of their survival, are on the whole higher species, we find it difficult to get away from the idea of a scheme of progress which in its continuity is purpose. And when finally we are aware of ourselves as men, the temporary culmination of the movement which we can foresee will yet endlessly progress, our bodies, the earth itself falling away as the now unnecessary scaffolding of a life that is spiritual, when we are aware of ourselves as minds comprehending the process and realising it as having this particular character, we are tempted to ask not merely, Was it worth while? but we can suggest that in the creation of human personality we can not unreasonably discern the temporary goal of the world's development, and so can speak of that development as purposive. On such a view death is no more the end of the individual's

life than the moment of birth is the commencement of his life; both are mere changes of environment. The ideal of which we become aware is interpreted by us as a purpose higher and greater than ourselves which is working in us and has been working all through the stages that led up to us. In our human lives this supreme purpose becomes conscious for the first time to other than the Eternal Mind. They live most highly who most wholly assist and are nearest to it in thought and activity,—its most perfect instruments. Yet they are a part of Nature, there is no break, and it is contrary to all analogy to suppose that that same purpose has not been working through all the preceding stages. Man can consciously assist it, and so it works more rapidly to-day, but that it was not in the earlier stages is the more difficult thesis to establish; not to believe in its existence in these earlier stages leaves us with a break, a miracle of unbelief.

Further, this purpose—if it be such—can exist only in or for a mind, the Divine Mind, immanent and operative in Nature, feeling and working its way, as it were, to perfect self-expression and self-realisation. Now the interpretation of Nature reveals an orderly and broadly progressive evolutionary process, and the patient researcher is never put to final intellectual confusion, as would be his experience were the Universe a chaos instead of a cosmos. On the contrary, every stage in the adaptation of the human mind to Ultimate Reality has brought with it a corresponding unmasking of that Reality, whereby the partial illusions of previous stages have been corrected.

We repeat, then, that in human activity—in its history and society which are themselves a part, the

outcome of the cosmic process—we find a clue to the whole, since we cannot leave that out which seems to be the temporary culmination of the process in which it is so deeply rooted; for while of only a small part of our past do we make use at any moment when we *think*, it is as the result of the whole of it that we *are*. Human life, as lived on its noblest plane, is full of meaning,—contains a meaning, not fully clear, indeed, but still the mainspring of most human endeavour. To conceive of the whole process as purposive is indeed to transfer to the whole the character of the part, but much of the difficulty in this seemingly illogical transference will disappear when we represent to ourselves what is involved in the magnitude and complexity of that whole—the association, *e.g.*, of the living with elements in which Life never was manifested or has ceased to manifest itself, and which will therefore not so clearly or directly manifest purpose.

Further, what we know to be true of the part—for it is impossible to eliminate the conceptions of intelligence and reason from human life—looks as if it were true of the whole, and the hypothesis works. For man is not merely a *z*, the end product of a series, *a*, *b*, *c*, *d* . . . He is not a mere end product in a linear series, but something that is interconnected on all sides with everything else in the universe, so that he is inexplicable apart from the whole, and the whole is incompletely interpreted without him. This universe, which does not merely contain but actually produces and combines the material particles, in association with which human thought and feeling are alone known to us, must itself stand in some sort of kindred relation to thought and feeling.[1] The part owes

[1] W. H. Mallock, *The Reconstruction of Belief*, p. 186.

its specific character to the whole: the whole is that in which all the intermediate stages are implicit in a perfect synthesis.

This is, however, a very different thing from maintaining that the whole significance of everything on this planet is summed up in its relationship to man. Yet there is no vagary in maintaining that such relationship is a real aspect of all meaning. To do so is not to insist that the Carboniferous came into existence solely and expressly to supply coal to mankind. Still, as a matter of fact, we do get coal therefrom, and it plays a complicated part in human life, and so is far from being unrelated to a reality which occupies so large a portion of the field of existence. Coal and its value enter into the meaning of the Carboniferous flora as an objectively valid fact, when the objectivity of a thing is taken, as it ought, to include every aspect of its significance—its social relations in this case as well. "The very possibility of extracting from a thing a value shows that the possibility was in it, and therefore that it is a veritable part of a universe which sums up all actual relationships."[1] And the more one learns about these relationships the more one realises how great is the universe, how fathomless must have been the initial meaning that has unfolded into the outcome of to-day, which will in turn develop into a result commensurate with the travail of a universe.

The reality of the world is revealed in the whole rather than in its parts. Some explanation is wanted of the interaction and interconnection—the co-operant toil. A cross section of the world taken at any particular point or moment will never give a complete statement of reality, for it is a process, and involves

[1] *The Religious Conception of the World*, by A. K. Rogers, p. 102.

duration. Assuredly the end is not behind us, therefore we need not look to beginnings: the ideal, the living spring that moves the whole, will not completely disclose itself even in the present; but to the trusting heart and wistful mind will growingly be revealed.

CHAPTER XII

EVOLUTION AND CREATION

DESPITE the progress of the last fifty years at once in Science and in Biblical interpretation, it is still difficult to avoid the instinctive association of the idea of creation with certain conceptions supposedly derived from the majestic utterances with which the Book of Genesis opens. Possibly no passage in the world's literature has been the arena of more intense wordy warfare. Even yet the din of controversy over these verses has not wholly subsided, but in the growing calm their undertone of a sure sense of God begins again to rise above the lesser insistences that have hitherto seemed to mean more to their interpreters. The day is fast approaching when infinitely more arresting than the story of the controversy itself will be the wonder how any misunderstanding ever arose at all.

In offering an interpretation the modern critic begins by disarticulating two Creation Narratives, of which the first, comprising Gen. i.–ii. 4[a], belongs to P, the Priestly Narrative, while the second, including the story of the Fall, and covering Gen. ii. 4[b]–iii. 24, is referred to J, the older stratum, the date of which may be assigned probably to the ninth century B.C. The Creation Narrative of P outlines a cosmogony which was the inheritance of all the

Semitic peoples, set down in this instance about the time of the Babylonian captivity, say 500–450 B.C., by a learned and pious Israelite, possibly a priest. And yet his version differs from all other versions of the same story as rendered by sacred writers of Israel's far-off kin, for he has been inspired, by the divine Spirit directly and indirectly through truths handed down and developed by a long line of prophets and teachers, to assert in these verses, (1) a pure and sublime monotheism. The mould of the Babylonian cosmogony, polytheistic and mythological, is retained but purified, and deliberately used by him, even with some contempt for it,[1] to give external shape to his assertion that the One God was the sole Creator of the universe and of every constituent of it, giving expression, as with the ease of speech, to His divine thought and purpose. (2) That this one eternal and omnipotent Creator had placed Himself in peculiar and close relations to man, not only constituting him the crown of creation, but forming him in His own image in expression of His desire for near and loving association with him. (3) Of this communion of man with God the sign and seal is the Sabbath, an institution whose strictly divine origin demands its observance as an essential factor in the development of the race.[2]

In the literary structure of the narrative, features like the parallelism of its clauses,[3] the recurrent phrases, the sharp antitheses, the dramatic setting of the whole,

[1] Cf. A. Jeremias, *The Old Testament in the Light of the Ancient East*, p. 175.

[2] It ought to be mentioned, however, that in Gen. ii. 1–3 there is no specific mention of the Sabbath, nor indeed any command concerning its observance. The simple statement is that God desisted from creative work on the seventh day and that He blessed and hallowed it. The writer antedates in his schematic representation.

[3] Cf. R. G. Moulton, *The Literary Study of the Bible*, p. 71.

and the forward movement to a consummation, all point to its poetic idealistic character. The standpoint is that of a devout man meditating on the world as he sees it in relation to its ultimate origin and to himself, and expressing in gratitude of heart his overwhelming sense of its clear witness to God. The majestic simplicity of the passage is ill-adapted to the involved theologisings with which men have sought to embellish it. Thus the conception of creation out of nothing has been associated with a Hebrew word that conveys no suggestion of the idea, and is often used of the regular production of terrestrial forms of life.[1] In fact, there is not a trace of such an idea in Scripture from beginning to end; it is a late mental importation.[2] Even more tangentially others have imagined the days to represent great æons of time. But the conception of the Hebrew writer is surely that of a natural day bounded by dawn and darkness. He puts the work of the Creator into the working week of any ordinary labourer. At the end comes the Sabbath rest: God worked and rested, so must man.

[3] Creation, from the Scriptural point of view, is a unity of which man is the head. The creation began, and progressed towards man; after him none other creature was created.[4] The Old Testament conceives the world as a moral constitution with God behind it. The world is a human world, yet also a moral world—the means of intercourse between man and God. It is the fact of the moral character of the universe that explains how the external world is dragged into man's

[1] Ps. civ. 30; Isa. xliii. 1; Amos iv. 13.

[2] Cf. 2 Macc. vii. 23, and later, some of the Early Fathers.

[3] The two following paragraphs are largely based on reminiscences of an unpublished lecture by the late Professor A. B. Davidson.

[4] Ps. viii. 5.

relations with God, reflecting these relations according as they are peaceful or disturbed, and even falling into a state of dissolution in the day of man's judgment.[1] Man is king over Nature, but he is a constitutional monarch. He is her best, put forward by herself to rule over her. The relationship between man and Nature is no mere pre-established harmony: he feels himself to be a bit of Nature simply because he is so. The truth of his headship over Nature leaves indefinite scope for scientific research. Science cannot show that he is different from what he is; she cannot obliterate his spiritual nature. The basal interest of the first Creation Narrative lies in its theistic conception of things, its moral interpretation of facts. It does not quarrel with the facts. It simply asks, Under what point of view do you bring them? and it is very interested to answer that the ultimate causality is God. The processes may be very long or catastrophically sudden; they may be very varied both in character and scope. All such discussion may well be left to Science. There will be no conflict until Science maintains that the whole process goes on without the divine causality.

There can be no doubt that the Creation Narrative was capable of suggesting an idea of immediate creation to those who had no other conception of that process. The idea of immediateness in relation to the divine operations, however, pervades all Scripture. Scripture knows no Energy but God: all phenomena are immediately due to Him. This is the religious idea. Science cannot rob men of the feeling that what happens to them happens through God. Even if the old Hebrews had known all that we know, had understood all the steps in the divine progressive

[1] Isa. xiii. 10; Zeph. i. 15.

march of events, yet they would have seen God in all of them. They could not get away from the sense of the divine working hand any more than they could remove themselves from the divine presence. As one of them wrote:

> "Whither can I go from Thy Spirit?
> Or whither flee from Thy countenance?
> If I ascend to heaven, Thou art there!
> If I made my bed in Sheol, Thou art there!
> If I should take the wings of the dawn,
> And alight in the uttermost parts of the sea,
> Even there would Thy hand lead me,
> And Thy right hand hold me.
> Should I say: 'Darkness, cover me!
> And at night be it light about me!'—
> For Thee darkness is not dark:
> The night shines as the day,
> And darkness is like the light."[1]

Now, to this vivid awareness of the universal immediateness of the divine presence there corresponded a strong sense of the immediacy of the divine working.

The adoption of such a standpoint with relation to these Creation Narratives gives relief from a number of embarrassing situations. The necessity of admitting the incompatibility of the first narrative with the long established truths of science, or even with the second narrative, has as little claim on our regard as the inclination to applaud subtle demonstrations of the anticipation in the same record of the most recent physical achievements. In Revelation man has never been taught anything that he could learn for himself, and it is derogatory to the divine wisdom to think of it unfolding scientific detail to a pre-scientific age, or conveying fundamental religious truths by means of an unintelligible vehicle. Strictly, the pages of Genesis

[1] Ps. cxxxix. 7–12 (Wellhausen's translation).

and the data of scientific text-books are incommensurate. It is as if one attempted to equate the symbolism of Watts' pictures with the chemistry or physics of his colour-box. The real marvel is that now that we know a little of the method of creation and have also learned the essential message and significance of these initial verses, the twin revelations of Science and of Scripture, so far from contradicting one another, prove to be complementary. Accordingly, we are left free to accept all the genuine results of scientific research that bear on man and his place in Nature, while we rejoice to find that in these verses we have light shed upon those ultimate questionings which Science can never answer. The lantern itself may by some be considered faulty. It is, at any rate, of antique design. But, on the other hand, the more the lantern is battered, the more the glass is broken, and cracks and flaws in the framework opened up, the clearer and stronger shines out the light that lightens all the universe.

The Doctrine of Special Creation.

The doctrine of Special Creation, till recently associated with these early narratives, derived much of its authority from the supposed fact of its acceptance through all the Christian ages, an acceptance that was also presumed to have been first seriously called in question as the result of Darwin's investigations. On the contrary, the doctrine has a very definite natural history, some of whose stages are well defined. One of these is foreshadowed in the distinct rejection of a literal interpretation of the Creation Narrative by St. Augustine (354–430 A.D.). In his mind there was a clear distinction between the definite creation of organisms and their gradual development under suitable

conditions out of invisible germs latent in unformed matter. He distinctly rejected the idea of the days as solar periods of twenty-four hours. His was an evolutionary belief in potential rather than in special creation. "Accordingly," he says,[1] "that unformed matter which God made out of nothing was at the beginning called heaven and earth, and it was said, In the beginning God made the heaven and the earth, not because this state of things now was, but because it was able to be. . . . Just as if considering the seed of a tree we may say that roots and trunk and branches and fruits and leaves are there, not because they are there now but because they will be out of it: so it was said, In the beginning God made the heaven and the earth, as if the seed of the heaven and the earth, since up to this point the matter of heaven and earth was in confusion; but because it was certain that from this the heaven and the earth would be, the matter was already called heaven and earth."

Nor was this view combated by St. Thomas Aquinas (1225–1274), the greatest of the Schoolmen. In fact, his positive contribution to the subject is simply an exposition of St. Augustine. "Nevertheless, with regard to the production of plants, Augustine holds a different view from others. For some expositors say that plants were actually produced each in its own species on this third day, as a superficial rendering of the letter (of Scripture) suggests. But Augustine, 5 *super Gen. ad litter.*, cap. 5 et 8, cap. 3, says that the earth is said to have produced herb and tree *causally* then, *i.e.* received the power to produce. This view he confirms by the authority of Scripture, for in Gen. ii. 4 it is said: These are the generations of the heaven and the earth when they were created, in the

[1] *De Genesi contra Manichæos*, Liber primus, Caput vii.

day in which the Lord made heaven and earth, and every plant of the field before it was in the earth, and every herb of the field before it grew. Therefore, before they appeared upon the earth they were made causally in the earth. However, this is also confirmed by reason; for in those first days God made the creature primarily or causally, from which work He afterwards rested, yet nevertheless in His administration of things created, works to this day in the work of propagation. For to produce plants out of the earth belongs to the work of propagation. Accordingly on the third day plants were not produced in actuality, but only causally."[1]

On the other hand, largely on the strength of an article by T. H. Huxley entitled *Mr. Darwin's Critics*,[2] it becomes clear that with Francisco Suarez (1548–1617), the last great name amongst the Schoolmen, should be associated much of the ecclesiastical responsibility for the promulgation of the doctrine of Special Creation. He devoted a treatise to a consideration of the six days of Creation in which he distinctly rejects the Augustinian principle of interpretation, affirms that the days referred to were ordinary days of twenty-four hours, and that the work of Creation took place in six such days. Huxley concludes in reference to Mivart's claim of Suarez as an evolutionist: "As regards the creation of animals and plants, therefore, it is clear that Suarez, so far from 'distinctly asserting derivative creating,' denies it as distinctly and positively as he can; that he is at much pains to refute St. Augustine's opinions; that he does not hesitate to regard the faint acquiescence of St. Thomas Aquinas in the views of

[1] St. Thomas Aquinas, *Summa Theol.*, Prima Pars. Quæst LXIX. art. 2.

[2] *Collected Essays*, ii. p. 120, originally in *Contemporary Review* for November 1871.

his brother-saint as a kindly subterfuge on the part of Divus Thomas; and that he affirms his own view to be that which is supported by the authority of the Fathers of the Church."

The simple fact is that towards the close of the sixteenth century, under a pressure the complex nature of which has not yet been fully elucidated, a theological reaction set in against the wonderfully sound positions of some of the greatest of the Fathers, and from the date of the burning of Giordano Bruno till the middle of the nineteenth century Special Creation became the orthodox teaching of the Church. Into this pressure entered the Calvinist insistence on the "pure word of God." The doctrine of Special Creation is a product of "the spirit of the Puritan movement, with its insistence on literal interpretation and verbal inspiration,"[1] a spirit that received superlative expression in Milton's account of Creation in *Paradise Lost*. The remarkable feature is that just about the same time taxonomy was coming into existence as a science,[2] and men interested in the classification of plants and animals were exercised about the question of species and their fixity. The stereotyping of the conception from the scientific point of view was accomplished in Linnæus' memorable definition: "Species tot sunt, quot diversas formas ab initio produxit Infinitum Ens, quae formae, secundum generationis inditas leges produxere plures, at sibi semper similes." Yet he only knew and described some four thousand different kinds of animal, and they not unnaturally seemed to correspond to the "kinds" of which he read in Genesis. No such interpretation of the Creation Narrative is possible for the

[1] Prof. E. B. Poulton, *Essays on Evolution*, p. 56.

[2] John Ray (1627–1705), the first great British taxonomist, was a younger contemporary of John Milton.

individual who realises that for every "kind" known to Linnæus more than two hundred are known to-day, and who further possesses and has understood the clear alternative view of Creation by evolution.

Yet it should not be supposed that fixity of species and special creation were subscribed to by all men of science and all theologians within the period named. "It is hardly credible to us," wrote Aubrey Moore,[1] "that Lord Bacon, 'the father of modern Science' as he is called, though he was only a Schoolman touched with empiricism, believed not only that one species might pass into another, but that it was a matter of chance what the transmutation would be. Sometimes the mediæval notion of vivification from putrefaction is appealed to, as where he explains the reason why oak boughs put into the earth send forth wild vines, 'which, if it be true (no doubt),' he says,[2] 'it is not the oak that turneth into a vine, but the oak bough, putrefying, qualifieth the earth to put forth a vine of itself.' Sometimes he suggests a reason which implies a kind of law, as when he thinks that the stump of a beech tree when cut down will 'put forth birch,' because it is a 'tree of a smaller kind which needeth less nourishment.' Elsewhere he suggests the experiment of polling a willow to see what it will turn into, he himself having seen one which had a bracken fern growing out of it! And he takes it as probable, though it is *inter magnalia naturæ*, that 'whatever creature having life is generated without seed, that creature will change out of one species into another.' Bacon looks upon the seed as a restraining power, limiting a variation which, in spontaneous generations, is practically infinite, 'for it is the seed, and the nature of it, which locketh and

[1] *Science and the Faith* (1889), p. 174.
[2] *Nat. Hist.*, Cent. VI. 522, fol. ed.

boundeth in the creature that it doth not expatiate.' Here the fact of transmutation is taken for granted, generation from putrefaction being sometimes called in as a *deus ex machinâ* to explain it. But Bacon certainly had no idea that the existing species of plants and animals represent those originally created by God," and his general standpoint was later shared by Buffon, Lamarck, Treviranus, St. Hilaire, Goethe, and other early transmutationists.

Likewise, in John Wesley's work, *A Survey of the Wisdom of God in the Creation*,[1] there occur these striking passages: "All is metamorphosis in the physical world: forms are continually changing: the quantity of matter alone is invariable: the same substance passes successively into the three kingdoms: the same composition becomes by turns a mineral, plant, insect, reptile, fish, bird, quadruped, man."[2]

"This immense system of co-existent and successive beings, is no less *one* in succession than in co-ordination, since the first link is connected with the last by the intermediate ones. Present events may make way for the most distant ones. . . .

"In the universe all is combination, affinity, connection. There is nothing but what is the immediate effect of somewhat preceding it, and determines the existence of something that should follow it. . . .

"There are no sudden changes in nature; all is gradual, and elegantly varied. There is no being which has not either above or beneath it some that resemble it in certain characters, and differ from it in others.

"Amongst these characters which distinguish beings, we discover some that are more or less general. Whence we derive our distributions into classes, genera,

[1] 3rd edition in 5 vols., 1775.
[2] *Op. cit.* vol. iv. p. 109.

and species. But there are always between two classes, and two like genera, *mean* productions, which seem not to belong more to one than to the other, but to connect them both.

"The polypus links the vegetable to the animal. The flying squirrel unites the birds to the quadruped. The ape bears affinity to the quadruped and the man.

"But if there is nothing cut off in nature, it is evident that the distributions we make are not hers. Those we form are purely nominal, relative to our necessities and the bounds of our knowledge. Those intelligences which are superior to us, discover perhaps more varieties between two individuals which we range under the same species, than we do between two individuals of distant genera. . . .

"By what degrees does nature raise herself up to man? How will she rectify this head that is always inclined towards the earth? How change these paws into flexible arms? What method will she make use of to transform these crooked feet into supple and skilful hands? . . . The ape is this rough draught of man; this rude sketch; an imperfect representation; which, nevertheless, bears a resemblance to him. . . .

"Mankind have their gradations, as well as the other productions of our globe. There is a prodigious number of continued links between the most perfect man and the ape."[1]

Although views of this general nature were also held by others within the Roman[2] and Protestant communities, their isolation as dissenters from the current narrower views was even more noticeable than in the ranks of Science. There is no doubt that the precise

[1] *Op. cit.* vol. iv. pp. 56, 60, 61, 85, 86, 92.

[2] Mivart gives the names of Father Pianciani of Rome, Cardinal Wiseman, and others (*Lessons from Nature*, pp. 440, 442).

authoritative Linnæan conception subscribed to likewise by Cuvier, the founder of comparative anatomy, and based supposedly on Scripture, by its very rigidity of definition served to obscure the vague conceptions of organic evolution adumbrated by some of the old Greek philosophers, naturalists, and even theological Fathers. It may be, as Dr. Dixey remarks,[1] that the Linnæan conception of the reality and fixity of species as corresponding to the deeply felt need of "an accurate nomenclature of the forms of life . . . perhaps marks a necessary stage in the progress of scientific inquiry." It may be that a reaction from the rich, warm Oriental views about the living earth and its living products with which the teaching of the Greek Fathers is suffused was necessary in order that men might examine more closely, and so form more accurate opinions as to the character of these products. But it is certain that what is required to-day is again a measured swing back from our cold Occidental static view of things tinged as it is with an aversion to Nature,—a legacy from the Latin theology that was grafted on to the pagan conceptions of our wind-swept northern ancestors,—to the palpitating Nature-loving thought of the Orient.

Creation and Providence.

How, then, shall we think of Creation? The alternative is between Creation by evolution, and Creation by intrusion and fabrication in separate acts. Each presents possibilities of design, except that on the former supposition the design will be on a grander and more comprehensive scale. Every man is a partial evolutionist. The difficulty for some is in realising that all the world processes are processes of growth, that all the varied forms of life of these and other days are interrelated

[1] *Church Quarterly Review*, October 1902, art. ii. p. 28.

and bound together by a common descent provided we trace their pedigree sufficiently far back, that "God hath made of one every nation of men."[1] For such minds glimpses of divine activity are caught amidst the doings of the human race, but the witness is scant amongst the lower creation, while the realm of the inorganic is as Sheol, which cannot "praise the Lord."[2]

"Science," said Clerk Maxwell,[3] "is incompetent to reason upon the creation of matter itself out of nothing. We have reached the utmost limit of our thinking faculties when we have admitted that, because matter cannot be eternal and self-existent, it must have been created." Our views of matter have been completely revolutionised since these words were written, and in the process it only seems to come out more clearly that there always has been a manifestation of God. "In the beginning, God": Science knows nothing of ultimate origins—she cannot dispute that sublime word. None the less a beginning is for her unthinkable. Her outlook to-day is upon a world that seems to vanish from the material point of view, but which is nevertheless an expression of Infinite Energy. The old terms remain, but their content is different; the old world is still there, but more than ever it is not in its inner being what it at first appears to be. Reduce the atom to its constituent electrons, explain the latter as particles of negative electricity revolving in an orderly method within a sphere of positive electricity, work out the final problem of expressing positive electricity in terms of ether, or what comes to the same thing, interpret both in terms of the single ultimate medium composing the material universe, and yet the wonder will not lessen. We are no nearer the

[1] Acts xvii. 26. [2] Isa. xxxviii. 18.

[3] Article "Atom," *Encyclopædia Britannica*, 9th ed. (1875), vol. iii. p. 49.

beginning, no nearer understanding what Creation is. The final analysis of the physicist leaves us with an invisible, all-pervasive Infinite Energy and an invisible, impalpable vehicle of expression; it pushes out beyond the last boundary of the seen, "compelling us to believe, as we were told long ago, 'that what is seen hath not been made out of things which do appear,'[1] but is the direct continuous offspring of an unseen universe and an indwelling yet transcendent Power."[2]

Features in the evolutionary process presenting the characteristics of purposive intelligence have led us to the recognition of a directive factor. In other words, the Infinite Energy shows the characteristics of Thought in its working. Of pure thought we know nothing; all we know are its activities and forms of expression within the limitations of our present existence. These are very varied according to the character of the medium of expression.[3] They include a wide range of activity, from the instinctive act with its minimum of consciousness to the definite effects that are wrought in material organic and inorganic as the result of mental action. In every case within the activity or behind its results is the energising Idea ever transcending its medium of expression; the failure of their presentation is the perpetual plaint of poet and of painter. Yet that which is everywhere manifest is the continual tendency of thought to objectify and externalise itself: thought is essentially creative.

On such a view the universe will represent partially and tentatively the content of a conscious experience

[1] Heb. xi. 3.

[2] Sir W. F. Barrett, *The Quest*, vol. i. No. 4, art. "Creative Thought."

[3] For detailed illustrative examples reference may be made to the suggestive article as above.

analogous to our own. Nature, that is to say, represents something that is real and true for the divine experience, although it is not the whole truth, not the whole reality. It is a partial phenomenal manifestation of the invisible Energy of the universe, like a visible cloud in a great encompassing atmosphere. This higher world order is the objective to the eternal, self-existent God through which and in which His omnipotent will acts and carries out His purposes.

Accordingly it is not helpful to think of Creation as an event at some definite point in time. To do so involves such a tremendous change in the life of Him of whom more worthily and fundamentally we think as unchangeable. It is difficult to conceive why just at one particular point in time God should give utterance and self-expression in Creation. We may, of course, fall back upon the fellowship of the Trinity as the *motif* of the pre-creational æons; we may imagine that we are preserving the divine freedom by positing Creation at some definite point in time. But neither conception seems to fit in with that dynamic aspect of divinity that is revealed in such a declaration as "My Father worketh hitherto, and I work."[1] "We cannot therefore say that there was a time when God had not yet made anything," concludes the evolutionary Augustine.[2] "Not then for the first time did God begin to work when He made this visible world; but as, after its destruction, there will be another world, so also we believe that others existed before the present came into being,"[3]—so had Origen expressed himself even earlier. "Die Weltgeschichte

[1] John v. 17.

[2] *De Genesi contra Manichæos*, Lib. prim. Cap. iii.

[3] Origen, *De Principiis*, trans. by F. Crombie, p. 255.

ist das Weltgericht," says the German poet: in which case every day is a Day of Judgment, and in a very profound sense any day may be a real Last Day. Likewise every day is a day of creation; every Spring a creative Spring. God is eternally a Creator.

Nor should we think of Creation as involving the absolute separation of Creator and creature. Whilst we must guard against all language that would involve identification of God with the world, yet must we bear in mind their intimacy and union. We may think of them perhaps as two elements in the one universe of Being, that which is permanent and unchangeable in itself, and that which undergoes or is subject to change. This means that Creation is change, the new being the creature. The series of changes as a series may be eternal,—probably is. It will always be truer to experience to think of that constant process of change that we call the flow or stream of events as without beginning or end, to think of the existence of the universe bound so closely to God as it is, as eternal or infinite, and as such simply because of His will. The series of changes in itself as a series is eternal, but each element constitutive of the series is not in itself eternal, but has a beginning and an end in time. So regarded, all that Science knows of causes and effects, of the sequences and laws of Nature, will constitute her partial answer to the problem of Creation.

Thus to think of Creation as an endless process so far as we know or can best judge of it compels us to realise in God the indwelling, informing Principle, the immanent reason of the development of the world. In employing the term "divine immanence" emphasis is laid on the continuous activity, the informing and sustaining relationship of God to the universe. It is, however, a relationship, not an identity. God is in the universe,

He is with it, but He is not the universe. The universe is in God and with God, but the universe is not God. Therein lies the vital difference between views pantheistic and panentheistic. His universal presence in the world is creative and sustaining through the operation of His will; without the divine Reason was not anything made that hath been made. Were He to withdraw, we could only imagine the shrivelling up of the universe, the vanishing of law and order—chaos, destruction, and dissolution. Yet is it in the realm of spirit—the ordering of the spiritual world—that most clearly the divine immanence reveals itself.

In these great topics analogy can aid us very little. Continually we find ourselves but skirting the shores of a great continent—that world which we know—when we had started out to chart the ocean of God's Being. It is characteristic, however, of our humanity to look into man's nature and see what reflection it can give us of that which we know so greatly excels it. Thus it is in reflection upon self-consciousness and our persistent self-identity that we reach the idea of the transcendence of God in relation to the world, meaning thereby that God is not exhausted, so to speak, in those aspects of Himself in which He is revealed to us. Such a thought forbids us ever to think of the universe as simply equivalent to God, and emphasises our thought of it as being the visible expression of an indwelling Divine Life which yet is something more than the sum of operations of natural forces. He is immanent in Nature, but He also transcends her. He is greater than all that we see or know: by searching we cannot find out God unto perfection. But in His transcendence we think of His self-existence, of His creatorhood, of His power to produce, sustain, order, and love the universe. Nor is there anything mutually

exclusive in the two aspects of Immanence and Transcendence; for we may be sure that that creative Spirit which is Love will be desirous of remaining in close relationship with that which He has willed into being.

Religious thought leads us to the conception of the World Principle immanent and transcendent as personal. If it is rational and intelligent, it must also be conscious and personal. Of course we cannot form a clear conception of such infinite unconditioned personality. We are certain that it is something richer in content than our personality. The divine activity, the divine nature can never be wholly understood by our finite minds, but we do not deceive ourselves when we live believing that the character of the World Principle has affinities with what is truest and best in our own activity. This is not to make man the measure of the universe, still less of God, but it is to realise that He is not something less than man. God is not less but more than a Person, or rather, personality proper is possible only to God. Every objection to the conception of the Divine Personality is simply evidence of the limitations and incompleteness of human personality.

Further, as a result of these considerations, we may be helped in our understanding of the much-misused words natural and supernatural. For one thing is certain, namely, that the universe admits of no dissection into parts that are natural, and parts that are supernatural; it is no image with natural feet and trunk of clay, and a head of supernatural precious metal. For the whole is both natural and supernatural—natural in so far as it is an objective expression of God, supernatural in the manner of its continued upholding by God. Nature is the orderly guise of the ultimate Spiritual Causality, and events are then natural in the

mode of their occurrence, and supernatural in that they all alike rest on that active energising Will in which all things consist. There is nothing from the Protozoa to man, from the pebble to the river, in which the natural and the supernatural do not appear in closest relationship, and the former is absolutely and at all times dependent on the latter. "The sole supernatural is that creative, quickening, inspiring life which is God Himself, and the natural includes anything and everything in which the living will is expressed,"[1] although the expression occurs in varying degrees according to the expressive power of the object.

Finally, we are also helped in our interpretation and understanding of Providence. Here in particular linger traces of that practical Deism with its occasional intrusions that is so damaging to the life of faith, and so contrary to experience as we know it. It is common to talk not merely of Providence, but providences—nay, special providences. Yet any particular providence will, when examined, always take the form of a definite specific co-ordination of events such as will be found in any providence, and, in the case of the special providence, all that really happens is that the divine purpose and causality in things are more apparent. At other times our eyes are holden or become dim, and the purpose and causality equally present, equally determinative, are missed by us. For if our conception of the relation of natural and supernatural is right, and anything is because of its significance, there is purpose in everything. But when we realise that divine wisdom and power are at work in all things, when we can prove in our experience that God is able to mould and coordinate the conditions of His world into a system that executes His will for us and through us, so that things

[1] W. Newton Clarke, *Christian Doctrine of God*, p. 341.

have a continuous significance, and in their most seemingly physical aspects can work to our spiritual advantage, we shall cease to lay stress on "special providences."

Our human tendency at once to avow and disavow is seen in reports of selective human disasters which conclude by reference to those who were "providentially saved."[1] But was there no providence for those who found no way of escape? Belief in God and in His Providence must cover all the facts and demands long-distance views. It demands time—perhaps Eternity; yet the patience of nature is the patience of God. Just in the degree that freedom means anything and man realises his power for evil or good will the divine plans involve failure and defeat no less than victory and success, loss just as well as gain. But when we see that these things do work "an exceeding and eternal weight of glory," that in the moments of most signal seeming defeat are born the convictions that ultimately prove invincible, that death's apparent victory consists but in the removal of the husk concealing the powers of an endless life, when, in short, we realise that we are in our Father's world, even if we cannot comprehend in fulness the mystery of His ways, then does the course of Nature become in a new sense to us the revelation of His care, the symbol of His providence. And this His providence is over all.

[1] Borden P. Bowne, *The Immanence of God*, p. 63.

CHAPTER XIII

MENTAL EVOLUTION

As the investigator gradually realises the potency of the evolutionary conception, it becomes increasingly clear to him that there is no point at which he can desist in his application of it as a modal interpretation. Yet, when he reviews his distinguishing features as man, he may well be pardoned if he shrinks from the thought of submitting those which he has deemed unique to the solvent influence of the new organon; on the other hand, he may rejoice in the vision of a successful corroboration in regions of more subtle influence. This difference of viewpoint is well brought out in the case of the co-discoverers of Natural Selection. "My object," says Darwin, "in this chapter is to show that there is no fundamental difference between man and the higher mammals in their mental faculties."[1] A. R. Wallace, on the other hand, states his belief that such a conclusion is "not supported by adequate evidence, and is directly opposed to many well-ascertained facts."[2] Evidently, we have reached a point where the difficulties are great, and we must proceed warily. Evolution is a jealous mistress; she will have all or

[1] *The Descent of Man*, p. 99. Darwin's treatment of Mental Evolution has hardly received adequate recognition.

[2] *Darwinism*, p. 461.

nothing. Let us inquire into the reasonableness of her claim. If she is worthy, the surrender, though hard, will not be refused by the loyalist to truth; indeed, his only course is to obey.

Evidently the psychologist and the biologist approach the question from different ends of a chain, so to speak. The former is impressed with the uniqueness of self-consciousness; the latter wonders at the sentiency of the simplest forms of life. The difficulty lies in getting each to appreciate the other's facts. Neither will dispute, however, that mind is in some way ordinarily connected with brain. What the relationship exactly is constitutes a problem of fundamental difficulty. It is not any more easy to conceive how mind exists in association with a brain than it is to think of it apart from a brain. The relation may be inscrutable, but we cannot insist that it is necessary. To this particular aspect we shall return later.

The biologist's contribution to the problem consists in showing that there has been an evolution of the organ of mind, and corresponding to this in some way, the comparative psychologist finds a certain grading of mental qualities. Yet the problem becomes quickly complicated even for the biologist. He will have traversed some considerable way in the upward grade of life before he finds any structure which he can describe as an organ of mind, and, further, however carefully he examines the taxonomic scale he will have great difficulty in pointing to any particular form of life, and saying: "There for the first time consciousness is present." Again, at every stage the interpretation is bound to be peculiarly precarious. Our knowledge of mind in our fellow-men is inferential; the only consciousness of which we are aware at first hand is our own. Particularly, therefore, have we to watch

against reading into the actions of other creatures such an antecedent psychical sequence of events as we are familiar with in the case of our own minds.

These difficulties meet us at the threshold of our study. We have learned to think of irritability as a fundamental characteristic of life, but at what precise stage such irritability, with its allied sensitivity, passes over into direct sensation, we cannot say. In the plant world we have expressions of this irritability in the geotropism of the tendril, and the sensitivity to moisture in the root-hair. In the Protozoa, where the whole creature shows the capacity of response, we see clear expressions of this irritability in the different tactisms, largely chemical and electrical, which, if they were everything, would involve almost complete determination of the organism by the environment. Loeb and others have indeed expressed all protozoan and other activities in terms of tactisms and tropisms, which form in their opinion the raw material out of which the higher instincts are developed. Touch alone, it is held, without the sensation of touch, is possibly sufficient for Ciliate life. The degree of irritability varies with mobility, yet it is felt to be unwarrantable to affirm accompanying sensation, particularly as many complex reactions go on in our bodies, *e.g.* digestion, without sensation. In fact, sensation is sometimes definitely denied to the Protozoa.[1] On the other hand, those who have given most attention to the matter find it exceedingly difficult to account for all protozoan activities in terms of physico-chemical attraction. If the power of conscious choice is taken as a criterion of mind, it is perhaps not possible to maintain this of the Protozoa; yet, on the other hand, it seems even more difficult to explain what the observer sees in terms of complete determinism. The

[1] *The Laws of Heredity*, by Archdall Reid, p. 368 n.

persistent refusal of the Amœba to ingest a grain of silica, while yet it will engulf the silicious shell of the diatom, is something more than the refusal of oil and water to mix, or the rushing together of H and O to form water. The predatory Ciliata show considerable cleverness in the way they capture their prey. H. S. Jennings sums up several years of work on the behaviour of the lowest organisms in these words: "This work has shown that in these creatures the behaviour is not as a rule on the tropism plan—a set, forced method of reacting to each particular agent—but takes place in a much more flexible, less directly machine-like, way, by the method of trial and error. This method involves many of the fundamental qualities which we find in the behaviour of higher animals, yet with the simplest possible basis in ways of action, a great portion of the behaviour consisting often of but one or two definite movements, that are stereotyped when considered by themselves, but not stereotyped in their relation to the environment. This method leads upward, offering at every point opportunity for development, and showing even in the unicellular organisms what must be considered the beginnings of intelligence and of many other qualities found in higher animals. Tropic action doubtless occurs, but the main basis of behaviour is in these organisms the method of trial and error."[1] Confirmation of these results is given in further work along different lines by S. O. Mast,[2] who states specifically that "the light reactions of *Stentor coer.*, both free-swimming and fixed, cannot be explained by the application of the tropism theory," *i.e.* the organisms

[1] *Contributions to the Study of the Behaviour of Lower Organisms*, p. 252.

[2] "Light Reactions in Lower Organisms," *Journal of Experimental Zoology*, vol. iii. No. 3, p. 392.

do not orient in strict and immediate relation to the direction of light rays, but by means of a specific motor reaction which consists in turning towards a structurally defined side, and is repeated many times if necessary, until "the anterior end of the animal happens to become directed from the source of light."

Pursuing the inquiry along biological lines, we find the next stage that merits consideration to be that of the typical gastrula, *e.g.* Hydra or the sea-anemone, where the outer layer, in contact with the environment, develops the sensitiveness to outward stimuli, and from it, eventually, in the case of the higher animals, the central nervous system—even the brain—is developed. This outer layer, or epiblast, is the primitive sensory organ; it is responsive to every kind of stimulus. The later differentiation consists in the development of special organs to respond more effectively to different kinds of stimuli. Further, we may assume, as a result of our ideas of the unity of the organism, that effects in the epiblast will cause secondary effects in the hypoblast, even before the development of a nervous system. In the Cœlenterate group, however, there is no differentiation into sensory and motor nerves: nerve fibres run directly from the sensitive cells in the epiblast to the muscle cells. There is no possibility of a *common* consciousness in the typical disconnected nervous elements, and the activities of the simple neuro-muscular mechanism of the group might still in great measure be effectively explained in terms of tactisms. Yet such an explanation, if incomplete in the case of the Protozoa, is more so here, although it is difficult to delimit its insufficiency, still more to posit consciousness as we know it.

The next stage that we may consider is that which is found in the organic lumber-room inscribed Vermes.

By this time there has developed in the two-layered gastrula a third layer, the mesoblast, which in the higher forms gives rise to the musculature, a system always found in close connection with the nervous system. Definite nerve cells are now introduced between the sensory and the motor fibres, where the impulse transmitted from the surface is transformed into an impulse communicated to the motor fibre and so to the muscle. Specific ganglionic groups of these nerve cells form the incipient brain. With growing complexity

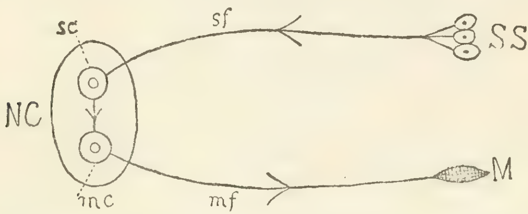


FIG. 8.—Diagram showing essential parts of an apparatus of exchange between the external world and consciousness.

N.C. nerve centre; *s.c.* sensory cell; *s.f.* sensory fibre; S.S. sensory surface; *m.c.* motor cell; *m.f.* motor fibre; M. muscle. Arrowheads show direction of transmission. (After Leconte.)

of the nervous system, the nerve currents set up by stimulation of the sense organs give rise in the ganglia to sensations—delicate, discriminating stimuli that release indirectly specific stores of energy collected in various masses of contractile cells. Nervous impulses received through the medium of the sense organs are in this way transmitted to the muscles.

As we pass round the different groups in this vast assembly, and indeed ascend farther, considering particularly Crustacea and Mollusca, we note definite increase in the size and number of the ganglionic masses, some of which serve as brain, together with growing

complexity of the connective nervous elements and sense organs. Yet it is unnecessary to break the largely unconscious automatic cycle of interpretation, although a linkage of stimuli accompanied by their temporarily retained impressions may have inhibitive results on the activities of a creature. We find many cases of successively different reactions to stimuli of the "trial and error" type, but we cannot easily think of them as deliberately put into practice, especially in default of an organ for such conscious deliberation. As automatic activities—more rather than less—they correspond to the lower reflex ranges of human activity. Unequivocal demonstration of consciousness, as humanly understood, is not yet available in the invertebrate realm, but what is noticeable above the Protozoa is, in Jenning's words, that "stimulation causes varied movements which do not all lead toward the condition finally attained, and that those movements which do lead toward this final condition (the 'optimum') are followed up more decidedly than the others. The behaviour may perhaps be most accurately characterised as 'selection from among the conditions produced by varied movements.'"[1]

When we pass up to the Vertebrate Kingdom we find in the most highly developed members of its lowest class a brain whose principal parts correspond in a general way to the parts of that organ in the most highly developed members of that great division of the organic world. The connection between vertebrate and invertebrate, whether through worm or eurypterid, is unimpeachable, though still obscure, and once the vertebrate brain has been definitely established the progressive development is marked and unmistakable.

[1] "Modifiability in Behaviour," *Journal of Experimental Zoology*, vol. iii. No. 3, p. 452.

Of the segmented nervous system of these humbler days even the most highly developed vertebrate form still shows reminiscences, *e.g.* in the spinal cord. Such a forward-moving ancestor would find it advantageous to have its sensory organs in the anterior region of the body, a situation retained throughout, though somewhat disguised by the human upright attitude. At the same time, the task of comparing the brains of individuals of the different mammalian orders is one of peculiar difficulty, and leads to statements which credit Elephantidæ and some Cetacea with brains more highly convoluted than those of the Primates.

So far, comparative psychology has not made any close study of the mental life of fishes, amphibians, or reptiles. The capacity of some forms for making new linkages has been demonstrated,—at any rate, such linkages arise within the nervous system,—but that they are conscious associations is still beyond strict proof. Granted that it is experimentally proven that the fish can learn by experience, and that it can modify its conduct in face of a new situation, yet it may be questioned whether what has happened is the result of a conscious acquisition of an idea or the unconscious selection of an impulse—whether it does not unconsciously feel its way rather than consciously think its way into the successful attitude or activity. Associations are formed in the brain, it may be held, in virtue of which instinctive impulses are modified, but as yet these associations are unillumined by active consciousness. Memory there is, but of that unconscious character that we have already seen associated with Semon's views on heredity.

At the level of the class Aves, we have reached a brain whose comparableness to the human brain is much more marked than at any lower stage, particularly

in the development of the cortex whose regional study has so greatly added to our understanding of the localisation of definite functions. With such an organ it would be idle to deny the presence of consciousness even if we should not expect that it was of the same degree or timbre as in the human subject. The gradual differentiation of association-areas from the sensory-motor areas, the successive development of posterior, median, and anterior areas of the cortex in strict association with progressively higher features of psychical life, may be traced in avian and mammalian brains with considerable exactitude. The bird can adapt itself in some degree to new situations, but the adaptation is probably due to the selection of one of several associations of sensory impression and impulse—that one which has a pleasing issue. The growth of association-area means an increase of plasticity—escape from a single inexorable response to stimuli. Yet as the human being makes unconscious associations, we cannot definitely state what degree of consciousness illumines the new mental associations of the bird.

The closer degree of correspondence between the lower mammalian and human brains intensifies the conclusions tentatively advanced in connection with the avian brain. Association of impressions with impulses is clearly demonstrated, together with that externally determined selection of one particular impulse which proved beneficial. On the grounds of comparative anatomy—slender enough in this particular connection—a related consciousness of these associations can hardly be denied. In fact, that which comparative experimental psychology seems to point to is a gradual enlarging of the area of association, a progressive liberation of the elements associated, a movement towards abstraction. The growth of

reasoning may be expressed by the increasing remoteness and comprehensiveness of the elements associated, the enlarged repertory of recorded impressions out of which response is made to the exciting stimulus; we may also naturally expect to find greater rapidity in association. In the anthropoid apes the progress in these particular directions increases with continued approximation in structure to the human brain, whose lowest types may be placed in a not unnatural comparative relationship with them. Especially with finer discrimination in touch and the progressive liberation of the fore-limbs from purely locomotor to prehensile and tactile function, do we find a correlation in cerebral advance that begins with lemuroid forms and is continued through the Primates group to man. The close regional connection of the higher "association-centres" with the motor-areas concerned in the movements of the hand and arm, and even of facial expression, suggests possibilities of mutual influence and reaction.

At this point the question becomes supremely important from the psychological side. With the increasing complexity of the organ of mind the psychologist has correlated an advance in mental power, yet in this particular phase where conceptual thought, and, later, self-consciousness emerge, it is maintained that the degrees of physical difference bear no relation to the mental differences in kind that are ultimately established. Hitherto, the discussion has been hindered by static conceptions of consciousness, and by hard-and-fast definitions of the typical human and animal mind that correspond to nothing in fact. Just as some of the older naturalists believed in isolated species, refusing to recognise intermediate links, so to-day there remains a certain unwillingness to realise

the graded expressions of the human mind as they may be found in various tribes. More remarkable even than the gradations in mental calibre amongst the higher mammals is the wide range of mentality furnished by the existing types of the human species. We can no longer sharply contrast the mind of man with that of the lower animal, thinking of the former as one specific type. Between the Berg Damara of South Africa and the European philosopher we have an enormous variety of type, and differences physical and mental comparable to those between the American monkey and the anthropoid ape. As we strive to hold in our minds not merely the range and degree of human mental evolution, but also the range of animal mental evolution, we shall not be so disposed to emphasise "breaks" as to find the missing pieces that will make the puzzle picture complete.

For example, the distinctions so apparently broad-based between abstract and concrete ideas are shaded out when we realise that some of the higher mammals have generalised ideas of certain objects; the dog has a concrete generalised idea of man apart from the particular concrete image of its master—the beginnings, that is, of abstract ideas. On the other hand, a race like the recently extinct Tasmanians had no word or phrase in their language that represented an abstract idea, and probably the abstract idea itself was conceivably attained by the continual superposition of similar concrete images, till, after the fashion of the composite photograph, the detail and particularisation vanished, and a vague community and essence of characteristic were left. Without speech, where art or sculpture are unknown, thought is not expressed, and, unexpressed, is probably rightly regarded as only faintly present. The actual details in the not unimaginable

development of self-consciousness in direct continuity with preceding stages are irreproducible simply because we do not have, and never can have, any direct record of the earliest stages in the evolution of language. The Berg Damara, neighbours of the Herero and Namaqua, are said to have lost their own speech, and now speak a Hottentot patois. The real language of the bushman, rich in the characteristic clicks, some of which passed over into the Hottentot dialects, is probably irrecoverable. Several modern tribes are unable to count beyond three or four. In short, abstract and concrete ideas are not so absolutely unrelated to one another as the usual definitions imply. We can even arrange a gradational series amongst modern types of higher mammal and lower savage—a series that assuredly has no genetic value, but which would represent closely graded stages of mental advance. Far down below that scale linkages of mental impressions first occur, speedily forgotten and drawn within narrow limits. Progress consists in the retention of impresses, the enlargement of the field of linkage, the disengaging of that individuality that is not subject to the unconsidered utilitarian determination of action. Man shares the capacity in common with many lower forms of having linkages arise in his mind between "situations or sense impressions and acts"; only the ability to learn by selection of impulses, a power of freedom that only very slowly emerges and is still evolving, is infinitely greater in his case than in theirs, and this ability is further obscured by his peculiar faculty "of thinking about things and rationally directing action in accord with thought."[1] We may not merely compare the perceptual abilities of man and the lower animals, and the possibilities of progress through "trial

[1] *Animal Intelligence*, by E. L. Thorndike, p. 285.

and error" and association, the selection meantime being more passive than active on the part of the organism even if accompanied by pleasure and profit; but we can actually trace the development of these abilities into that conceptual stage characteristic of man in which the selection is active, and determined more by himself than by the environment.

To have traced progressive stages in the evolution of the organ of mind is not, however, necessarily to have proved the evolution of mind. Yet in the light of the historical argument, within the records of the human race alone, the probability of such an evolution almost amounts to certainty. In an antiquity, to which every year of recent study and discovery seems to have added thousands of years, we can demonstrate along particular lines a progressive advance in cranial capacity, to which there must have corresponded a definite mental evolution, which is repeated in the individual life-history. In the early stages the human brain passes through phases broadly comparable to the brain of the fish, of the reptile, of the marsupial, and of the young anthropoid, till we are startled into considering why it is that this last stage so comparatively slowly passes into the typically human form. Later, the actual passage through the stages of reflex, sensation, consciousness—for a period the child speaks of itself in the third person—and self-consciousness is made; there at least the terms do have genetic connection so far as that is possible. Up till the end of the first year the intellect of the infant is largely of the animal type, the sole apparent difference being in the quantity and quality of the linkages: reasoning and ideational life have not yet arisen. Possibly the evolution follows the direction indicated by Thorndike of passing from the animal characteristic of feeling things in gross,

to the characteristic of human thought which "breaks up gross total situations into feelings of particular facts."[1] But to maintain that there is no solution in the facts of the ontogenetic history, and to insist on the uniqueness of the human series because it starts with a fertilised egg-cell that has in it all the potentialities of the later development, is to forget that no succeeding stage could ever be reached without some transaction with the environment, and that even that initial stage is not strictly such, as the germ cell in either case is linked with a whole antecedent heritage.

So far we have outlined stages in a possible development of the organ of consciousness and of intelligence in particular, but no real understanding of the question is possible without a fuller reference to those peculiar activities grouped under the name of instinct. Especially in the case of insects have they reached a remarkable stage of development. In many cases instincts are peculiarly complicated, and the solution of the riddle of their origin has not made any recent great advance. Geology reconstructs for us periods when as yet there was no winter (*e.g.* prior to the late Carboniferous), and we may well suppose that some of the extreme racial instincts, *e.g.* of insects, were evolved in reaction with the changed conditions that a lowered temperature involved.[2] The development of the seasons with their contrasted temperatures involved an acceleration of phases of the life-history—perhaps of the whole of it in the case of some insects—induced migration, additional protection for eggs, and other instinctive actions. During such profound changes the modifiability and adaptability that are characteristic of all living matter would be peculiarly liable to be moulded by the en-

[1] Thorndike, *op. cit.* p. 289.

[2] P. Hachet-Souplet, *La Genèse des Instincts*, p. 320.

vironmental pressure into those rigid associations of sensation and reaction that are known as instincts. Physically we must assume the connection of instinct with the nervous system, and it has always been a plausible supposition that instinctive actions are no more accompanied by consciousness than higher reflexes in the human individual, or those habits of unconscious memory or inference with which human psychology is acquainted. The analogy between the different castes of an ant community and the tissues of the human body is certainly closer than any that could be established between the powers of the ant and human brains. Ordinarily, instinct is supposed to be independent of intelligence, yet purposive, unaffectable by experience, involving the activity of the whole animal, and adapted to the survival of the species. Recent research shows that no such hard-and-fast definition is tenable. No instinct is perfect, and modifications and new departures are not unknown. That these departures have not been more definitely recognised is probably due to the scant study that has been given to individual insects and the probability that only very obvious deviations of great magnitude have been noted: we should probably see countless modifications on a slighter scale were our vision and observation keen enough. This loosening of the rigidity of definition does not, however, make it any easier to detect the relation of instinct to intelligence. Certainly, the most extreme forms apart, as we ascend the animal scale intelligence seems to replace instinct. In man at any rate instinctive action is at a minimum; he is *par excellence* the educable animal. A common view of the relation between instinct and intelligence finds in the former a fixation and automatic perform-

ance in response to a definite stimulus of an act originally carried out with a measure of intelligence. It is indeed tempting to suppose that in the case of man reflexes and instincts represent successful unconscious perfect performances of activities that in their original moulding were the subject of conscious and laborious effort, but which once perfected, leave consciousness free for higher endeavour. So far as certain secondary instincts and habits are concerned, this is no doubt what happens, but as an interpretation of insect instinct, it must fail, proving too much, for it implies a degree of intelligence which could hardly have stopped even with a perfectly developed instinct but must have reached out to some higher conquest. And even if human reflexes are perfect, man's primary instincts certainly are not: indeed his most characteristic instinctive impulses require definite guidance and development, and the same is true of all creatures. Many instincts are so complex, and involve adjustments of so many different kinds that it is not easy to see how they could have sprung into being, complete and all of a piece. The argument against their mutational origin seems equally valid against their origin as perfected instincts. The real difficulty in supposing that instincts are directly due to intelligence is the fact that most of them have reference to generations yet unborn of which the individual insect has no knowledge: it is not clear how such benefits which affect the race and not the individual could have originated in individual acquirements. The problem has been complicated by the tendency to dwell on the instinctive activities of alert insects, instead of realising that the solution must cover the no less instinctive though laboured activity of the mollusc as shown, for example, in building its shell. Such a consideration

immediately rules out the idea of instinct as lapsed or perfected intelligence.

Of recent contributions to this vexed problem none has created wider interest than the solution offered by Bergson in his *L'Évolution Créatrice.* "The cardinal error," he says, "which, from Aristotle onwards, has vitiated most of the philosophies of nature, is to see in vegetative, instinctive and rational life, three successive degrees of the development of one and the same tendency, whereas they are three divergent directions of an activity that has split up as it grew."[1] His analysis of the two faculties or modes of acting on the material world open to life, the one direct, "the faculty of using and even of constructing organised instruments,"[2] implying knowledge of things and concrete situations,[3] intension of knowledge abintrally acquired, the other indirect, "the faculty of making and using unorganised instruments," implying knowledge of a form (relations), extension of knowledge abextrally acquired, is now familiar, with its conclusion of the inevitable failure of the one mode as a means of interpreting the other. "Instinct is sympathy. . . . It is to the very inwardness of life that *intuition* leads us—by intuition I mean instinct that has become disinterested, self-conscious, capable of reflecting upon its object and of enlarging it indefinitely."[4] So superlatively conceived instinct is perhaps the nearest approach to God that we can discover in the objective world. Yet the Bergsonian conception of a supra-consciousness combining originally more than instinct, intuition, intelligence, appearing we know not where and gradually splitting into characteristic forms like instinct and intelligence in its endeavours towards

[1] *Creative Evolution* (Eng. trans.), p. 142. [2] *Op. cit.* p. 147.
[3] P. 157. [4] P. 186.

self-realisation, is difficult of application to the facts of organic life.

The *ensemble* of facts seems to indicate that the characteristic consciousness which we associate with man has evolved like any other character, and that as in the Protozoa we find in rudimentary form many cell characters of the higher creatures, *e.g.* contractility, digestion, assimilation, respiration,—even if the terms do not cover strictly comparable activities,—so also with the primitive adaptability and modifiability of Life's first offspring was associated something akin to a dim or diffuse consciousness.

How may we suppose that this dim consciousness first arose in the racial history? Of the requisites of life none is more fundamental than food. Whereas the crystal grows by adding like particles to itself, the organism grows by taking in unlike particles. The exertion of assimilating the unlike must have involved difficulty. We can hardly think of it as an inherent absolutely automatic power, even when conceived in terms of tactisms. The living creature lays hold on the food; that implies effort and energy. Effort is at the basis of all consciousness, its concomitant creative condition, and if consciousness thus results from effort, there must be a diffuse consciousness co-extensive with life. If the cell had got food without labour, there would have been no effort on its part, and so no development of consciousness. Further, once that faculty was in any measure developed, any tendency towards sessility and corresponding reduction of effort would have had the effect of causing growth to express itself largely in the development of protective structures, for the animal and the plant that could not avoid peril by moving out of the locality of danger had to protect itself, and sensitivity, thus shielded, failed to advance.

But further, in these simpler organisms, psychical life must have been wholly instinctive in character, sensation and reaction being welded under the direct determining pressure of the environment into specific activities. Later a stage came, not exactly definable, when within that sphere of instinct the original diffuse consciousness began to condense into consciousness as we know it expressing itself as intelligence. Already low down in the scale of life, as we have seen, we become aware in nascent form of the distinctive feature of consciousness as we behold it in man—namely, its timeless ability to disengage and recombine impresses from sensations received at different times, for the present good of the organism. Something interpolates itself between the stimulus and the immediate reaction historically impressed upon the organism by the environment (reflex). The interloper selects amongst past and present impresses and to that extent modifies reaction: herein lies the possibility of education. The bionomic value of such a power is at once evident. This with its growing capacities of realisation, assertive selection and rearrangement of inferences, and penetration into subtler aspects of the environment, is what is known as consciousness. By means of sensation it becomes symbolically aware of aspects of the environment, for the subjective qualitative sensations of colour are transmuted by it out of differing quantitative ethereal vibrations.

On the other hand, in insects, for example, their low-level consciousness had less resource; through a generally more limited set of sense organs they had not such wide possibilities of interaction with the environment, which therefore moulded their impulsive activities in well-marked instincts. The apparent perfection and definition arise from the great age of

the insect phylogenetically, associated with their extremely short ontogenetic history. The latter demanded, and the former has produced a noticeable limitation and exactness of life activity. Man, by contrast, is phylogenetically of yesterday compared with the insect. Consequently there has been little grooming or definite moulding of his instinctive impulses, and, further, this function of environment is increasingly taken over by the highly developed consciousness accompanying them, which is able to turn the edge of Natural Selection and control the instincts in large measure in accordance with other aspects of the environment. In virtue of this actively selective power of consciousness, this plasticity in response to environmental stimuli, this capacity for control of instinctive impulse, man shows himself supremely educable. Will is simply the assertion of an individuality which refuses to assent to the forced determination of the environment without consideration—which may dissent, but can also consent. Free will and consciousness alike are progressively developing faculties. In these activities man is peculiarly aided by his innate powers of memory—the capacity to make mental acquirements and revive conscious experience. The experience of the lower creatures is in comparison with his a somnambulistic series of disconnected moments, a continual consciousness of the present, in which only scantily are experiences greeted as familiar or unfamiliar.

We thus conceive of a diffuse consciousness accompanying the instinctive impulses that express the life of humbler forms, which was yet unable to mould them, this function being performed by the environment. In fact their instincts are a partial reflection of the mind of the environment in its ultimate sense. But as

life progresses and consciousness develops, the latter interacts with various aspects of the environment in the control and moulding of the instinctive impulses which are still there and have also developed though not to the same extent. Consciousness, however, is basal and primary; it is even not impossible that activities which appear completely reflex and instinctive now were more directly accompanied (though not produced) by consciousness at an earlier phylogenetic stage. "Certain facts in the comparative physiology of the vertebrate nervous system tend to show that in the lower forms (amphibia) a certain degree of consciousness presides over the functions of the spinal cord, which in mammals is devoted to reflex actions."[1]

On the views that have been enunciated in the preceding pages it would appear that we are left with Consciousness and Infinite Energy as two ultimates: we may even venture to think of the former as the informing spirit of the latter. What then is the relation of mind to matter? The latter under the electronic theory is finally interpretable in terms of energy—atomic charges of electricity,—so that the difficulty does not lie there. Rather is it in the relation of the individual consciousness to its "brain." All assumptions of a causal, *i.e.* productive relationship, are, however, ruled out by the simple consideration that if sense and feeling are indirectly allied with or generated by the inorganic, *e.g.* by the grey matter of the cortex, as on the materialistic hypothesis, then quantitative relations must necessarily ensue. Double the quantity of grey matter will involve double the quantity of consciousness. Yet this is precisely what is shown not to be the case. For the brain, like many

[1] "The Problem of Consciousness in its Biological Aspects," C. S. Minot, *Science*, N.S., vol. xvi. No. 392.

of the other organs, is a paired instrument consisting of two cerebral hemispheres, and while in the control of voluntary muscular movements and in the reception of bodily sensations, both hemispheres are employed, yet for all the ordinary and distinctive functions of mental life — reasoning, recognising, remembering, speaking—they are wholly independent of one another, and one alone is used. Neither hemisphere, as it were, knows anything at birth. The individual employing them has to learn everything, and in learning he slowly modifies the organ. Yet in it all he employs only one of the two hemispheres, usually the left, as associated with the right hand stretched out in the first mute inquiries of childhood.[1]

Accordingly it is evident that brain matter in itself does not originate speech or thought, since both hemispheres would have on all analogy contained such centres. As a matter of fact either hemisphere can function in this way, but only one is employed. Mental capacity is not increased by the double brain any more than the faculty of sight is doubled by the paired eyes. The individual employs one of the hemispheres in the development of his thought and speech, which accordingly can stand in no directly productive relation to mind.

With such an ultimate in consciousness viewed as the informing spirit of energy, we may conceive of its progressive manifestation through instruments of increasing organisation and complexity, each better adapted for partial revelation and expression, till finally in man is produced an individuality that is able to come into direct relationship with the Ultimate in its

[1] With left-handed individuals the speech area is found in the right hemisphere. See W. H. Thomson, *Brain and Personality*, where the whole question is fully discussed.

most personal aspect. What the nature of the interaction between spirit and matter is we do not fully comprehend: theories of parallelism are as little helpful as the old idea of production and secretion. That which was in the beginning was self-conscious spirit. Its manifestations may change with the processes of the suns, but those that develop into likeness with itself share in its eternal glory.

CHAPTER XIV

EVOLUTION AND MORALITY

At no point in the discussion of Evolution is it more important to remember with Henry Drummond that to give an account of a thing is not to account for it, than in considering the relation of evolution to morality. The subject is closely related to the evolution of mind. We have noted a broad difference of degree between the mental life of man and those forms that are lower in the animal scale. Whereas, in the latter we see a life that is largely tactic and automatic, a consciousness that is mainly perceptive and impulsive, a responsiveness that is singular or instinctive, in man we find a growing freedom and increased selective possibility of response, while the conceptual character of his mind enables him not merely to interrogate and anticipate the environment, but also to put himself under the inspiration of ideals or ends. In such union with the environment he works its work, and in a sense selects himself for survival. In a peculiar way also the evolution of morality is almost a function of the evolution of society. Morality has no significance apart from the relation of an individual to some other individual, human or divine.

As in much else, we find that Darwin made the first attempt to treat of the origin of the moral nature in

accordance with evolutionary principles.[1] For him the moral sense is an instinct similar in origin and character to other instincts. In order to be morally right any line of action must result in some advantage, in which case the adoption of such line of action would be fostered by natural selection. So far as illustration is chiefly offered by Darwin, the advantages are to other members of the same community, *i.e.* the moral nature is traced to the social instincts of certain gregarious animal forms and of savages, which in turn are probably a development of the parental or filial instincts. In some cases the illustration bears more directly on the individual life. Thus the bird that finds its food supply diminish under the severity of a northern winter can find salvation in migration. However this instinct arose, it obviously is of individual and racial importance. In obedience, therefore, to the demands of the environment it has to migrate. But if the bird could incipiently realise its relationship to present and future conditions it would incipiently realise that it "ought" to migrate. Already even at this stage a struggle may be noticed between conflicting instincts, as when, "late in the autumn, swallows, house-martins, and swifts frequently desert their tender young, leaving them to perish miserably in their nests."[2] In the sequel, those individuals will be preserved under natural selection whose most assertive instincts prove to be the best adapted to their good. In the case of man, intelligence enables him to understand his social instincts inherited from earlier stages, and the realisation of the opinion of his fellows will begin to act as a factor in his surrender to one or other of competing instincts; indeed, such a consider-

[1] *The Descent of Man*, chapters iv. and v.

[2] *Op. cit.* p. 165.

ation may ultimately come to be of more importance than the pain or pleasure associated with the gratification of the instinct.

As civilisation advances, and the smaller tribal companies of earlier periods united in the larger social communities of later days, the individual's destiny becomes more firmly bound up with that of the larger whole, even than it was in the days of the smaller collective unit. The growing differentiation of this whole makes him increasingly dependent on it. Natural selection therefore tends to accentuate the qualities that make for tribal, rather than for individual, survival. Now, tribal strength is expressed in mutual dependence and union, in loyalty and courage, and in the exercise of these qualities the individual comes to subordinate his personal advantage to that of the tribe, and so tends to ensure their survival and development. Those qualities tending to the advantage of the community, and so secondarily to that of the individual, are taught and practised from generation to generation till they become inherited habits. In the end their utilitarian character takes on an aspect of authority. Man in virtue of his conceptual powers formulates rules of conduct which serve as the collective morality of the tribe, observances which are respected now as duties, and as such conscientiously performed. "Ultimately our moral sense or conscience becomes a highly complex sentiment—originating in the social instincts, largely guided by the approbation of our fellow-men, ruled by reason, self-interest, and in later times by deep religious feelings, and confirmed by instruction and habit."[1]

Ideas closely related to the above have been expanded into systems of scientific ethics by Clifford,

[1] *Op. cit.* p. 203.

Spencer, and others.[1] Broadly, however, they come under the same limitation of presenting the development not so much of morality as of its physiological basis, of giving accounts of the external aspects of moral progress and of the development of the apparatus of the moral nature, but not accounting for morality. Darwin gives suggestive descriptions of the origin of definite instincts, and then says that they comprise man's moral nature. But is it possible on such a view to state broadly which instincts go to constitute that moral nature, and at what stage others which were not initially so constitutive, became so?

We can see that, in its earlier stages, moral character—and especially is this true of all those elements that are distinctively social in their expression—may be subjected to natural selection much as physical characters. The fact, however, that it is possible to trace the development of morality does not necessarily imply that that development has throughout followed the method of development of physical characters. In the case of the latter, natural selection has played a very important part. But in the case of the former, just in proportion as the character becomes distinctively moral does natural selection cease to have to do with its development. The moral character is like the student that has passed beyond the capacities of his early instructor: the latter ceases to have any hold on him. It is impossible to indicate the precise point where the change is effected, just as in the case of the development of other critical capacities. The early stages are forwarded by natural selection, but a point comes where the individual takes a direct and active

[1] Cf. more recently *The Origin and Development of the Moral Ideas*, by Edward Westermarck; and *Morals and Evolution: A Study in Comparative Ethics*, by L. J. Hobhouse.

part in moulding and fashioning the characters in question. This abrogation of natural selection is clearly visible, as Professor Sorley maintains,[1] at that stage where sympathy and benevolence, universally established, continue to grow and expand, although that growth as universal is no longer of the character of a survival-determining factor, inasmuch as no particular community is being benefited by such exercise at the expense of others. In fact, on theoretical grounds the opinion might be regarded that such a growth would be an element making for elimination. The characters in question grow and become more general, but not as the result of a natural selection, where all show them in the survival-determining degree. They grow and become more general, and in precisely that degree do they eliminate the possibility of that rivalry which is of the essence of natural selection. It is perfectly possible to describe the differing outward expressions of morality that have characterised successive stages in human evolution, but the notorious failure of many attempts at explanation of the ways in which savage races behave to-day makes all theorising with regard to past conditions very precarious, whilst the endeavours to deduce or construct from such an evolutionary account of morality something of the nature of an ideal or end of conduct now, is a task of superlative difficulty. To associate it, *e.g.*, with the most persistent impulses in human nature—those that have been productive of the most abundant and most harmonious life—is to take that ideal from the past; but to find an ideal in the past is to surrender the idea of progress. As with every character physical or spiritual, the real problem is not that of survival, but of arrival, not of persistence, but of origin. Here the initial crisis seems to be

[1] *Ethics of Naturalism*, p. 153.

directly dependent on the dawning of self-consciousness and that reflection upon ends that constitutes a new dimension in which evolution thereafter proceeds. Again, there is no absolute break, but there is the emergence of a new phase of evolution, when the individual in conscious relation with the spiritual environment participates directly in the progressive movement. "If I were called upon to exhibit the chief determinants of human life as a single chain of causes and effects . . . I should do it thus. Working backwards, I should say that culture depends on social organisation; social organisation on numbers; numbers on food; and food on invention."[1] At either end of this simplified series of determining elements in human life is a spiritual factor,—the tool-using capacity that is so characteristic of man,[2] culture significant of mind. In accompaniment of all this, morality evolved, being shaped by human beings even yet in process of acquiring freedom of will and in the way to attaining individuality.

As the result of notable investigations we have learned a very great deal about the development of morality. Yet after all, moral character represents but a certain way of struggle—a method rather than actual quality, measurable and determinate. There is no such thing as goodness in itself, but there is good thinking, good speaking, good serving. Accordingly the origin of customs presents no difficulty in a sense, for ultimately they simply represent different *kinds of ways* of doing things. Customs are forms of social activity synchronous with human life; what we want to learn is why one way of doing the same thing rather than another way was selected. If the "primitive

[1] R. R. Marett, *Anthropology*, p. 155.

[2] Cf. emphasis laid on *Homo faber* by H. Bergson, *Creative Evolution*, p. 146.

moral idea is simply a subjective reflection of the customs of the tribe," which, sanctioned by tradition and representing that which every one did, had "its echo in the consciousness of the individual as the standard of right,"[1] we want to know why it took one particular form rather than another. It is said of the original Tasmanians that they had no abstract terms in their language, *e.g.* for right and wrong, but that does not mean that in their actual life they did not recognise certain actions as things to be done and certain others as things not to be done, *i.e.* as right and wrong. No tribe will ever be found without the rudiments of morality, without customs, because these represent fundamental distinctions, different ways of doing things that were a part of life itself. To reflection alternatives, in some cases numerous possibilities, are always open; and religion, which was at first intimately associated with morality, is a distinctive human characteristic to which it is foolish to look for analogies in the lower creation, as it implies amongst other elements the power of reflection. Nothing is more distinctive of man than his religious capacity, that attitude of mind which, in its recognition of dependent vital relationship to a more fundamental Power, controls conduct. Conceivably, certain of the elements that comprise the religious attitude may be traced in a modified degree to the lower creation, particularly in such forms as have been closely associated with man, but in default of the power to comprehend a universal it is playing with words to attribute religion to the lower creation. Religion expresses awareness of the essentially spiritual nature of man, and of the natural desire for linkage and communion with the Spiritual Source of things.

[1] "Evolutionary Ethics," by W. R. Sorley, *The Quarterly Review*, April 1909.

It is the origin of that initially groping outpush which we call faith, those spiritual tactisms that alone rightly orientate human life.

Human morality, as we have seen, is not a constant. The values have changed in the course of history; the criteria are far from uniform in different parts of the world to-day. Yet it is the highest developments that must be considered in any explanation, and it is these that give the clue. Even when we have traced in actual detail the successive stages in the evolution of morality, that would not invalidate the fact, which after all is the only important one, of our possession of such a nature, or in any way modify it, *quâ* moral nature. If conscience has a natural history, it is none the less conscience. If incipient morality can be traced in lower stages of life, that does not make it any the less morality in the higher. But as a matter of fact, "the further we go in examining any naturalistic theory of ethics, the clearer does it become that it can make no nearer approach to a solution of the ethical question than to point out what courses of action are likely to be the pleasantest, or what tendencies to action the strongest; and this it can only do within very narrow limits both of time and accuracy. As to what things are good, it can say nothing without a previous assumption identifying good with some such notion as pleasant or powerful. The doctrine of evolution itself, which has given new vogue to naturalism both in morality and in philosophy generally, only widens our view of the old landscape. By its aid we cannot pass from 'is' to 'ought,' or from efficient to final cause, any more than we can get beyond the realm of space by means of the microscope or the telescope."[1]

However we may explain morality in association

[1] W. R. Sorley, *Ethics of Naturalism*, p. 326.

with inherited instincts of racial good, however we think of race instincts of the general good slowly obtaining the mastery over the individual instincts associated with pleasure, however we may finally conceive of conscience as the insistence of the cumulative racial experience of the beneficial and injurious, yet there remains the fact that this conflicting issue between the racial and individual interest can never have been settled initially as the result of the experience that it would lead to most abundant life. The will-to-die often involved in such subordination of personal advantage to the good of society as in the palæolithic prototype of a Father Damien can have involved no knowledge of such good, and must have often actually resulted in the individual's death: the adoption of that particular method of struggle did not, at any rate, repay *him*. So, once again, to maintain that evolution supplies its standard of morality in what actually survives as the result of natural selection is to ignore much in the physical zone of the environment that is unaffectable by that factor. It is wholly to forget that the demands of the psychical zone have often led to the immediate physical extermination of those who yielded to them, but by that very circumstance the ideals in question gained a wider recognition and led to the survival of the race.

Such type of action cannot therefore find its explanation in any instinct due to a racial experience of what is advantageous or disadvantageous. It can only have been undertaken under the direct stimulus of that spiritual aspect of the environment in communion with which all psychical progress is made, and whose realised insistence is the "ought" of human endeavour. Such a response whenever it occurs will doubtless include as result the ultimate preservation of that in other

lives for which the sacrifice is made; it has even meant directly the preservation of the race. It is not necessary to suppose that in the earlier stages of the development of morality, any more than to-day, such a response was given by any great numbers of individuals. The modern investigator may give an account, speculative or otherwise, of the meaning of those objective expressions of morality that take the form of tribal customs, but it seems probable that this meaning, however true, is known to but few of those who observe the custom. In many instances it has become a tribal habit, and persists as a survival. Yet the breaking away from that custom, as also its origination, was the result of some commerce with the spiritual environment on the part of the individual or individuals who instituted or dispensed with it. In imaginative reflection partly—the result of the working of some objective datum in the mind—the new custom arises; how exactly the suggestion comes we do not know. That it should be initially in great part often debasing presents no difficulty to those who believe in the ascent of man from an animal stock. Later, the feeling or emotion resulting from such commerce may be purer than its expression. But to seek the origin of the response simply in physical aspects of the environment, or in some development of past social instincts, to strive to find the explanation of that which is of higher moral worth than anything known up to that point in previous stages whose characters were increasingly animal, is to repeat in its most disastrous form the old error of considering the developing organism apart from its environment. The moral nature in correspondence with God develops until it reaches a stage where the organism is meaningless apart from the highest development of its being.

CHAPTER XV

EVOLUTION AND EVIL

THE problem of evil has baffled men from the beginning. In its direst form, that of moral disease or sin, it has miserably defeated all human efforts to cope with it. To deny its existence is something worse than affectation: it is moral suicide. To say that "the higher man of to-day is not worrying about his sins at all"[1] is simply to refer to an insensibility, a numbness that is the sure forerunner of spiritual death: to find satisfaction in the fact is not to befriend humanity.

Evil as we know it and as commonly conceived, appears in two aspects, the one physical, the other moral. Much of the former is directly due to the latter, as may be seen in any hospital. Indeed, apart from sin and its direct and indirect consequences, the problem of evil is not wholly unmanageable. In fact it is largely a relative effect, receiving content and expression in the relativity of all phenomena. Thus consciousness notes relations as knowledge, but these relations are revealed through differences. Without relativity of sensation there would be but monotony of sense-perception in which nothing could be distinguished. A monotony of sound would ultimately fail to arouse the sensation of hearing. Truth would not be perceived to the same extent as truth were

[1] Sir O. Lodge, *Man and the Universe*, p. 220.

there not falsehood. So evil may arise as the result of faulty and imperfect expression on the part of phenomena, for everything that enters the phenomenal world is subject to limitations. It may also arise too easily from failure on our part to really understand and orientate phenomena.

Further, all manifestation of energy involves a certain overcoming of some reluctance or resistance. As soon as resistance is developed the force comes into play—a steamer would make no headway without the resistance of the water. No activity is manifested save as pulses of resistance being overcome. Withdraw the resistance and the power is impotent. No doubt, electricity, if it could think, would regard the inert resistance of the carbon as an evil to be overcome, but in the overcoming the electricity is revealed and would be self-realised. Physical evil is a real thing to *us* in the process of the attainment of goodness, but it is the attaining which is the most real and most necessary thing to us. Evolution, in its insistence on the essentially dynamic and developing character of the world process, saves us from the necessity of attributing any absolute character to physical evil.

With moral evil the case is otherwise, particularly as regarded from the point of view of the fully developed consciousness. Here it cannot be *explained* in the sense that physical evil can; it is more absolute than relative. Nevertheless a certain development can be traced in relation to it. Nothing, indeed, is more obvious in history than the progressive raising of moral values, so that practices which at one stage were good as compared with those of an earlier period which they have supplanted, yet in turn become indefensible and are discontinued in the fuller knowledge and heightened moral sense of a later period. To realise this is not to

minimise or deny moral evil. It is indeed an element in the process, but not the most real element nor the most imposing one. Reality appears as a process in which evil is being progressively overcome.

So far as the individual is concerned, pain and disease are the common heritage of man and brute alike, by reason of their sentient bodies. We have already realised what is involved in the capacity for pain, and the extent to which it operates as a factor in organic progress. In human experience pain has often proved to be God's kindest schoolmaster, hardship and affliction but courses in a divine curriculum of Love.[1] In the tribulation of pain the individual and the race have learned more about the real value of life than in the ecstasy of pleasure. And the more one thinks of it, the more difficult it is to see how spiritual beings could have been trained in character worth the name without those special methods. It is not so much the uniting sense of pain as contrasted with the too commonly isolating sense of happiness that makes us reconsider the relation of pain to evil;[2] it is the fact that the thing that is thought to be evil can be transmuted into the fibre of a better, nobler being by the self-controlled, determined, and trusting heart that places itself in the right attitude to it.

Our problem accordingly is the account that will be given of the origin and implications of sin in the light of Evolution. Now this compels us to distinguish clearly what we mean by the word "sin," for such failure has been the cause of much misunderstanding. In the Shorter Catechism sin is described as "any want of conformity unto, or transgression of, the law of God." This must be held to imply a conscious moral agent (otherwise the word is logically

[1] Psalm cxix. 71. [2] *Hibbert Journal*, vol. vii. p. 129.

applicable to the actions of the innocent child, the untutored savage, and the man-eating tiger): it further implies a law, and knowledge of the law. "Whosoever committeth sin transgresseth also the law: for sin is the transgression of the law;"[1] "where no law is, there is no transgression,"[2] and where no knowledge is (*i.e.* of law), there is also no transgression. Were these simple truths realised from the beginning of theological thinking, much of the confusion with regard to this dark theme might have been avoided. For not merely does sin imply knowledge, but its source and secret being lie in the human will. There is no such thing as sin apart from sinning men and women. Its apparatus, so to speak, its arena of operation lie in our human nature: its essence is the selfish misuse of elements that in themselves are not inherently bad, but are rather neutral and unmoral. Sin and sinful are ethical terms, and should not in strictness be applied to other than the apostate will, should not be predicated of a nature that supplies impulses, which in their direction and misdirection are good or bad. Sin, that is to say, is not merely a distinctively human character, but is conditioned by the stage of human development. Nevertheless sin is a word of such limitless content that we might well assume that in certain aspects we should find analogies with features in the lower creation. As a matter of fact we do, and it is this circumstance that gives such power to certain passages in Drummond's *Natural Law in the Spiritual World.* Few who have read the chapters on Degeneration, Semi-Parasitism, and Parasitism can ever forget them. Sin viewed in relation to its own character stands out as the bad and reprehensible; in relation to man and what was

[1] 1 John iii. 4. [2] Rom. iv. 15.

expected of him because of what he knows, it becomes the abnormal, the unnatural, a departure from the standard. In the serial stages of arrested development, degeneration, and parasitism, and in phenomena like reversion, we can find physical analogies in the lower creation that with startling likeness prove descriptive of the mental and moral conditions of man.

It cannot be too strongly asserted that to investigate the history of the doctrine of Original Sin, or even to inquire speculatively, so far as we may, into the conditions under which sin emerged, is not in the slightest degree to minimise or explain away the terrible, the exceeding sinfulness of sin: still less is it to question the need for a redemption. We have held that the evolutionary conception of the origin of man can in no way detract from the glory of man as he is: similarly we assert that the evolutionary account of sin can in no way belittle its appalling significance. There can be no dispute about the fact of sin: that is given in modern experience. What may be questioned are certain received accounts as to the origin and implications of sin both in the individual and in the race. And even what is questioned is not so much any strictly scriptural account as a particular interpretation of that account.

This interpretation, largely associated with the name of St. Augustine, is to the following effect. "Our first parents," to quote certain sentences from the Westminster Confession [1]—"being seduced by the subtilty and temptation of Satan, sinned in eating the forbidden fruit. This their sin God was pleased, according to His wise and holy counsel, to permit, having purposed to order it to His own glory. By this sin they fell from their original righteousness, and

[1] Chap. vi.

communion with God, and so became dead in sin, and wholly defiled in all the faculties and parts of soul and body. They being the root of all mankind, the guilt of this sin was imputed, and the same death in sin and corrupted nature conveyed to all their posterity, descending from them by ordinary generation. From this original corruption, whereby we are utterly indisposed, disabled, and made opposite to all good, and wholly iuclined to all evil, do proceed all actual transgressions." So far as the doctrine of Original Sin is construed as a doctrine of Original Guilt—imputational in the Augustinian sense—it has been rejected by the developed Christian moral sense of to-day: indeed, it is a contradiction in terms. It belongs to a period in which the value of the individual was as yet undeveloped. The conception of the solidarity of the human race may help us as we strive to realise the universality of sin: it helps us not at all with a theory of universal guilt as extending over men from one man's sin. So far as the doctrine of Original Righteousness is concerned, it is too speculative a superstructure to rear upon our first parents' ability to react to a command and their awareness of their nakedness. Even were it granted, the successful instigation to sin as a psychological fact under such circumstances raises a problem very difficult of solution, while the idea of a single isolated initial act with such disastrous racial consequences is unassisted by any analogous experience in the developmental psychology of to-day. Finally, a doctrine of Original Sin while helped by our sense of the solidarity of the human race finds that assistance only in the physical side where it is of least assistance: those nodes of individuality that we considered as rising to the surface of the physical stream of life have no genetic relation to one another. Indeed, all forced

correspondence of a doctrine of Original Sin to some inherited corrupt nature reduces the former to an aspect of physical evil.[1] At the same time we have to find some explanation of that in relief of which the doctrine of Original Sin was promulgated, viz. the paradox of experience between the sense of personal responsibility for sin and the feeling of an innate bias towards evil.

A true doctrine of sin connects itself with a view of man as a highly developed personality. The consciousness of sin varies with the individual: it is graded by the penal code. In every aspect of it there are the basal principles of selfishness and lawlessness, which may differ in degree. As the individual becomes growingly aware of the beauty of holiness, his sense of sin deepens. Progressively it has a history: at no stage is there a cataclysm. The expanding antiquity of man enlarges the time area within which the development of every quality that characterises him took place, and as this is realised, the difficulty in positing any exception to the gradual development of his faculties will be intensified. The evolutionary conception compels us to think of his gradual emergence from the purely animal, a creature of impulse, unrestrained, unconscious of the idea of control. We speak of baser passions: so far as they correspond to animal instincts the baseness consists simply in the lack of control. Sin is a corollary of knowledge, but it is the frequent exception to the truth that knowledge is power. The Bible is profoundly right in pictorially conceiving of the entrance of sin as due to eating of the tree of the knowledge of good and evil.

We have seen reason to believe in man's gradual physical progress, and mental development. We

[1] Cf. F. R. Tennant, *The Origin and Propagation of Sin*, p. 38.

naturally associate with this his gradual emergence from an impulse-governed existence, non-moral and animal.

The reconstruction of those ages of incipient morality is of course for ever impossible, harder even than the task of tracing the evolution of mind. There are no concrete expressions of such morality, as in the case of mind, till very long after it is there. None the less we may be sure that in the tumult of instinctive life, associated as that must have been from the beginning with intelligence, moments developed when the mechanism worked less smoothly, and in those slower moments was developed that which ever after altered the whole character of the movement. Man in that morning *Götterdämmerung*, with his incipient consciousness of self and awakening moral sense became aware of the possibility of choice between alternatives, and knew these alternatives as higher and lower. Sin entered through his voluntary acceptance of the lower: that is the historical fact. It was that which had been done often before in innocency of anything higher, but so far it was not sin. In persisting in doing that which he had formerly done, now knowing it to be lower and aware of other possibilities, he sinned and fell,—fell back from the realisation of life on a higher plane. Having made his fatal choice —a decisive choice that came more easily the next time—he was immediately overcome by a sense (necessarily germinal) of remorse, and knew in himself that he had been for ever banished from his garden of innocence.

Such history as we have enables us to trace in part the slow development of individuality. So far as the study of contemporary savage life assists—and the assistance is much less than is ordinarily conceived, for

no modern savage tribe represents the unchanged descendants of forms that once stood in the direct line of human ascent—or the oldest historical documents attest,[1] we obtain first hand witness to states of society in which the tribe is the unit, the tribal instinctive custom the sole yet scant inhibiter. Group action signifies the failure of outstanding dominance: no individual has succeeded in that long continued victory over impulse which would work a new departure. The reflecting mind has not attained that steady inward turning of itself upon itself, without which there could be no awareness of alternatives as higher and lower, and which is therefore the prerequisite of all moral advance: conscience implies self-consciousness.

An external descriptive account can, however, in no way even summarise the inward process in virtue of which advance took place. Even could we be sure of the particular initial moment in which an individual became first aware of alternatives of conduct as higher and lower and voluntarily chose the lower, it would be difficult to affirm that sin definitely entered at that moment. The action was certainly sinful, but the entrance and victory of sin has never been a momentary affair; it is an age-long process, alike in its origin, its persistence, its elimination. Yet is there nothing necessary or inevitable about it. We may discuss the origin and implications of sin, never its origin and function. It was not a necessary stage in the development of man. The struggle is inevitable, not the fall. He might have overcome in the beginning: he might have followed the gleam. The instinctive impulse and appetite, strong in some cases because of their basal utility to life, the conscious desire when

[1] Joshua vii. 15, 24.

faced with the dawning recognition of a higher if more difficult way, present the arena for struggle and resistance. As when the electric current is turned on, and the arc lights flicker and burn unsteadily till the power avails to transfuse the recalcitrant material, so the darkness of man's early life was only gradually and fitfully illumined: that there was a return to darkness at all after the initial flash is the statement of the Fall.

But if the racial records can help us little in dealing with what are really prehistoric moments, and the evidence from contemporaneous savage man is difficult because in fact irrelevant, there is a line of enquiry to which we may turn with expectation. For if the Recapitulation Theory holds any truth in its interpretation, we should expect that it will not fail us here: and particularly impressive will be its verdict in the physical field if we should find that in the subtler area of the spirit, the data as we read them prove in accordance with the general line of interpretation. Now every honest man who reads the third chapter of Genesis feels that it at any rate describes his individual experience. For, as a child, there was a Golden Age of Innocence in his life, but one day temptation came and he fell. Consequently it is not impossible, nay it is probable upon biological analogy, that the childhood of the race was lived in innocency, but that a day came when a cloud hid the sun. To this we may add the testimony of many men, good and bad alike, to a feeling of uneasiness and of dissatisfaction in view of the fact of sin, to a feeling that they are not what they ought or were intended to be, to a sense that they have in them some bias that hinders the accomplishment of the resolves of their better moments. "I find then the law," said Paul,—and he spoke for many a man,—

"that to me who would do good, evil is present . . . ."[1] That is to say, he has the feeling that the present state of matters, this inner warfare, is not the right or natural one, that this body of death in him from which he prays to be delivered, is an acquired character—acquired, however, by himself.

What is the character of the genesis of sin in the individual life? It is an easy prophecy that every development of child psychology and morality will only serve to bring the ontogenetic story into closer agreement with what we are driven to think of as the racial history. We have already realised how slow is the dawning of self-consciousness, how the child is first a bundle of sensations, how consciousness arises, and later on only are the final awareness of self and its assertion in the will attained. Particularly do we see the emergence from the impoverished instinctive phase in the faculty of imitation through which the child would go beyond itself and ally itself with other forms and forces. Similarly we are compelled to recognise a stage in which it is the slave of impulse. Out of this it passes, as the moral consciousness awakens. Everything has to be learned by the child, and in those early days of non-moral miniature animalism and later savagery, we seem to have the recapitulation of the story of the race. How long we wish they might remain in the garden of their innocence, but a day comes when knowledge of good and evil is attained, deliberately the lower is preferred and they are banished from the garden. And the reason why this failure is persistent and has met with only one exception is not because some ancestor failed. Sin is not an ancestral affair; it is a personal affair. The others have failed for precisely the same reason that he failed—that

[1] Rom. vii. 21.

difficulty in struggle with the lower self that comprises the inwardness of life, the secret of all progress. The characters are there—impulses and instincts—that made for survival in the lower plane, but as the Environment becomes unmasked and the individual becomes aware of the possibility of some new conformity, realises that his survival now depends on his control of that which formerly was unchecked, they come to be regarded differently and are the arbiters of his fate in a new way. If the choice is made in one direction with any degree of uniformity, habit makes it easier. The moral elements are like many physical elements: their character depends upon the use that is made of them. Fire and water may be for man's improvement or his destruction; around the lower appetites develop the fairest blossoms of human character or its most degraded expressions: and even those other features that are more purely spiritual have possibilities of good and evil according to their usage and their development. Sin emerges only with the will, and consciousness of alternative action: it is the surrender of the self to the lower dictate, acquiescence in the old state of affairs, failure to struggle towards the higher. Subduing of self, the aligning of conduct with the glimpsed ideals of the race—which are simply the summed contribution of individual glimpses—therein lies the struggle, for impulse is instinctive and chafes against control. The mere recognition of the possibility of restraint issues in lawlessness, a natural state of rebellion by the hitherto uncurbed spirit. The curbing has been removed from the external physical sphere to the internal and spiritual. It is a change of control, with awareness first of the fact and then of the necessity of control, and the change has arisen as a result of the reaction with that Environment which in its proximate aspects is physical

but in its deeper essence is spiritual. The community of life involving community of tendency and so of struggle has as its corollary the universality of sin. Once reason had arisen with its possibilities of permutation and combination in impulse and motive, it enormously extended the area over which sin could develop.

Such, then, is the view to which the evolutionary conception leads us. It implies a certain advance in that critical moment in that man now knew that there were courses of action higher and lower, and that both were open to him. From the history of evolution we learn to think in terms of a gradual progressive advance, not of such cataclysmal reversals or alterations of advance and retrogression as the older view suggests. It shows even within the strictly historic period definite progress in religious idealism, and we cannot be wrong if from what we know of this curve of advance we extrapolate it into the eras where knowledge is not so available. The religions of to-day contain vestigial remains of their earlier stages, as did the Hebrew religion ; language and customs still hold within them evidence of their prehistoric stages. Yet from no quarter do we get witness to a stage of primitive goodness or high culture from which later stages represented a persistent fall. The more we learn of the history of the race the more does the idea of a lapse from a clear consciousness of God and perfection of relationship with Him into a condition of universal savagery become unthinkable. Such an interpretation may perhaps appear more revolutionary than the change in our views of the Creation Narrative. At any rate it demands a further investigation, and, as in the other instance, we shall best help ourselves by returning to the original narrative and endeavouring to learn exactly what it teaches.

In Genesis ii. 4–iii. 24 has been preserved the Biblical account of the origin of Sin, an idyll of haunting beauty and pathos that Gunkel rightly describes as "the pearl of Genesis." Unfortunately, as in some other cases, the simplicity of the original story and its deep moral truth have been overlaid with wrappings of later theologising foreign to the original account, and productive of seeming inconsistency with the less vital truths that have been won by the slow progress of Science. This narrative by J, the critic tells us, contains a story which, though not strictly paralleled in other Semitic folklore, still has Babylonian affinities, a story that gives no piece of scientific anthropology, whose age is but as yesterday compared with the proved antiquity of the human race, yet tells us that which every man can verify in the forum of conscience. How largely we have covered it with later significance may be gathered from the universal identification of the serpent with the Evil One, of which there is no trace in the narrative, by assertions of original righteousness about those who were indeed living in childlike innocence and purity but had no knowledge of good and evil, and by failure to realise that in the narrative itself there is distinct recognition of a dawning moral sense which has to be stimulated by the imposition of a command. The consequences of the transgression are visited on the sinners' posterity: but there is nothing to show that this sinful tendency is so regarded. Even the wonderful proclamation of perpetual enmity between the seed of the woman and the seed of the serpent has not strictly the direct promise of ultimate victory that is so often read into it. All that we can literally gather is a tale of lost innocence[1] resulting from wilful disobedience to a

[1] "They knew that they were naked," Gen. iii. 7.

command: that is the kernel of the story. The Bible is commonly supposed to teach that men fell from a state of original goodness: the study of man indicates that his fall was rather failure to become that which he ought to have become, interference on his own part with his normal development. However diverse the two readings may be superficially, they agree in their representation of this moral crisis as the consent of the spirit to evil in the form of self-indulgence and self-will.

Concerning this stage of original righteousness, and more particularly of that high degree of culture and intellectual gift that are commonly associated with our first parents, it certainly is not scripture that warrants us in so thinking. How far Milton is again responsible for the culture attribute is a fair question. With regard to the other character which has greater theological bearing, we may note that even Paul, while perhaps connecting the sinfulness of the race with the sin of one man, yet does not speak of him as having previously lived in a condition of original righteousness. The traditional view represents a being of noble character and definite knowledge who yet does not know good from evil, and who as the result of an imperious desire to know is driven out into the long night of Palæolithic and Neolithic experience. Such an interpretation violates not merely scripture and history but the moral sense.[1]

[1] It is of some interest to note that if J gives us a historical account of man as originally sinless, which, however, is open to doubt, he himself does not connect this sinlessness with the divine image in man. In fact, J nowhere mentions the divine image. That occurs only in P (First Creation Narrative), and when P mentions it, there is no corresponding reference to sinlessness. That is to say, the conception of original righteousness is nowhere connected with the divine image by J, nor, on the other hand, is the divine image connected with sinlessness by P.

In any attempt to picture to ourselves what sort of a primitive being man was, both physically and mentally, we must not suppose that we find his replica in the lowest races of to-day. Both mentally and morally he must have been very unlike them. All that is praiseworthy in them would certainly have been found in him; but further, there was in him the potentiality of all that has come to desirable fruition in every aspect of life, social and individual, to-day. In him lay that capacity for progress which has evaporated in the set modern savage races, whose immobility can only be melted or influenced by external impulses. And yet he might have become something better.

Man alone is the author of sin; nevertheless the presence of moral evil as that which is absolutely antagonistic, contrary to the character of God and hated of Him, has often been felt to be an indictment of the divine omnipotence. All expression is, however, limitation, and in the creation of this world, peopled by free-willed human beings, we perceive a self-imposed limitation of the Divine Spirit. In such a world, indeed in any world of moral implications, was involved the possibility of moral evil,—a possibility that cannot have been unforeseen: but for its actuality the sinning individual alone is ultimately responsible in every case. The divine purpose evidently admitted of the possibility of sin, but in no way entailed it. Sin we cannot believe to have been any direct part of the divine purpose: it is a subverting consequence of the gift of freedom. About that purpose we can be tolerably certain, for the end of life is the formation of character, the development of strong and virtuous spirits which may be meet partakers of His glory. How this could be achieved without the exercise of freedom it is impossible

to imagine, and through such freedom sin entered, but once it appeared, it gave God the opportunity—an opportunity that would not have been offered in a sinless world—of revealing Himself in that fundamental manifestation of self-sacrificing love. In the stresses of our human lives caused by evil and by our own sin, is given the opportunity for the manifestation and realisation in us of the redeeming spiritual forces of God's love.

Man has to overcome himself, to set himself free from the domination of the lower motive, to win and develop the will to do right. The more intimate his correspondence with the spiritual aspect of the Environment, the easier does this become. In some of its proximate aspects it may appear to be working against him, perhaps to be dragging him down. Yet to every action there is an equal and opposite reaction. In himself there is the inertia of the gross, corresponding to what was considered to be a bias, Original Sin. There is the wilful opposition to be overcome, the possible contingency of a free will. As the individual overcomes the grosser forms of this resistance he becomes more sensitive to its finer and more subtle forms: possibly there will be always something to be overcome. Yet we may believe that in the reaction against evil, human freedom will increasingly take on the form of goodness, and man thus be brought into growing likeness to God.

CHAPTER XVI

SCIENCE AND MIRACLE

IF that conception of the sphere of Science from which these studies started is in any degree correct, it seems to carry within itself the determination of her attitude to miracles. Whatever the miracle is, it is ordinarily conceived as something that transcends our experience and which is therefore in great measure unintelligible, although not necessarily incomprehensible. But this does not preclude its possibility: in fact, the whole conception of the world beyond our senses for ever shows the unscientific character of the dogmatism that categorically asserts that miracles do not occur. It is obvious from this illuminating idea that what is not known or regularly experienced, must be so infinitely more and vaster than the things we do know, that in dealing with the great conceptions of God and the Universe and their relation to one another, all that the man of science can tell us is comparatively little. His realisation of the definite limitations of the instruments whereby the data for knowledge may be acquired, and his sense of the small proportion of impinging stimuli to which his sense-organs can respond, compel him to admit the infinite possibilities of phenomena with some of which, constituted as we are, we can possibly never come into relation, some of which we become cognisant of by means

of such added sense as the galvanometric test, some of which we may become aware of in supernormal conditions of our mind or receptive organs, but which nevertheless are continually hinted at in experience and may very occasionally be realised in exceptional circumstances. The discovery of argon or of the Röntgen rays does not mean that these phenomena came into existence for the first time at the moment of their discovery. They were there all along, exerting their definite though unrealised influence until the time of their manifestation. On general lines, it seems unscientific to say that such and such things, *e.g.* any specific miracle, did not or could not have occurred. There is no warrant in Science or in anything that we know for saying that miracles do not occur. No man knows enough to be entitled to say so.

On the other hand, it should be carefully noticed that this is not to adopt the mistaken attitude of an older apologetic and base the argument for divinity on our ignorance,—and so find God in the gaps of our knowledge, or see Him only in the bizarre. Religion has suffered from the adoption of this attitude, whose natural consequence was that, with the spread of Science, God was banished from His world. Take the case of any great discovery,—knowledge is ordinarily acquired in instalments. At the first stage the conception of it might be represented by $a+x$, where x, the unknown = God: the next stage might be represented as $a+b+x$, but as the series $a+b+c$ . . . . grows, x becomes a vanishing quantity. The ideal of Science is to get rid of x, *i.e.* the unknown. Or in particular illustration, we may suppose that a savage tribe in days gone by explained the phenomenon of a solar eclipse by supposing that God covered the sun with a blanket: this would be an explanation wholly

in terms of x. Later, under the Ptolemaic theory, a scientific explanation of the same phenomenon would be given not wholly complete, and that we might represent by $a + x$, where x would represent the mysterious, the unknown = God. Under the Copernican theory we may be said to have an explanation that is represented by $a + b$, complete in itself. But does this necessarily mean that there is no x, that God is driven from His world? By no means: the mere fact that in terms of $a + b$ we can predict that the next total solar eclipse visible from any part of the British Isles will take place on 29th June 1927 gives us a new conception of "the Father of lights, with whom is no variableness, neither shadow that is cast by turning." We win back on a higher plane our sense of divinity in thus realising the stability of law, the essential soundness and solvency of the universe. A more correct representation of these phenomena would be $\dfrac{a + b + c \ldots .}{x}$ where x might represent the ideal of the divine immanence,—the continual sustaining and control of all things by God. We must not lose our sense of the fact of the divine energising simply because in some small measure we have come into understanding of its method of operation.

From the question of the possibility of miracles, it is natural to pass to consideration of the attitude of Science to the question of evidence. Here, necessarily, textual criticism of the authorities and consideration of the times and circumstances under which the miracles were wrought will all have to be taken into account. We shall have to remember that all antiquity believed in miracles, and that the accounts of the Scriptural miracles come to us from an age that had no conception of natural law in our sense of the

term. Even to-day, for great masses of mankind all the world over the miracle, in the crudest sense of the term, is a too credible thing. While the allowed possibility of miracle requires us to admit all the Scripture miracles for purposes of examination, yet this does not mean that all the recorded miracles are even probable. It is just here that scientific consideration of the text and circumstances will offer its assistance and perhaps justify us in our surmise that some of the miracles associated with Elijah and Elisha are possibly popular tales, or that the story of the withering of the fig tree may have come over from the realms of parable into those of miracle. It is a mistaken attitude to insist that all the Biblical miracles stand or fall together. The instructive story of the relation of Joshua x. 12–14 to the Book of Jasher shows how easily misinterpretation enters into our understanding of the Scriptures, and is a tribute to the value of the critical study of the Bible. Particularly with regard to the miracles in the New Testament, we must recollect that the narratives reflect the spirit of an age that if not without elements of scepticism yet ordinarily "expected that Divine action would (as we should say) run counter to natural laws and not be in harmony with them, and that the more Divine it was the more directly it would run counter to them. We may be sure that if the miracles of the first century had been wrought before trained spectators of the nineteenth, the version of them would be quite different. But to suppose this is to suppose what is impossible, because all God's dealings with men are adapted to the age to which they belong, and cannot be transferred to another age. If God intended to manifest Himself specially to the nineteenth century, we should expect Him to do so by other means. We are then

compelled to take the accounts as they have come down to us. And we are aware beforehand that any attempt to translate them into our own habits of thought must be one of extreme difficulty, if not doomed to failure."[1]

Again, with regard to the scientific attitude towards the interpretation of miracles, it will be allowed that Science cannot deal arbitrarily with anything that cannot be fitted into the network of relations and uniformities as known at any definite period in history. That which is, provided it be duly authenticated, even if it be unique, is a tyrant before whom all laws must bend, for laws alone have their validity and their utility in virtue of things which are. Each single instance of objective actuality in Nature is the result of such a mass of relations that we cannot say what can happen and what cannot. In any case of apparent antagonism, the law must give way, not the duly authenticated fact, for the sole authority of law rests on the pre-existence of fact. Nothing happens through law, though everything happens according to law. The law as known while indicating something regulative of Reality yet tells us nothing of what is essentially constitutive of Reality.[2] Natural Science is powerless to tell us how in general it is possible that anything happens, or what all can happen. There is nothing of which we can say that it is contrary to Nature though it may be contrary to our knowledge of Nature, since we do not *know* the real Nature of things so far as it comes under observation as all-effective Energy, and we are therefore unable to gauge the possibilities of its productivity. The man of science must never assume

[1] Article, "Jesus Christ," W. Sanday, *Hastings' Dictionary of the Bible*, vol. ii. p. 625.

[2] Cf. A. W. Hunzinger, *Das Wunder*, p. 107.

that the limits of his methods are the limits of Reality. And this is the more readily admitted in proportion to the degree in which Science actually recognises the incompleteness in the statement of her laws. There is always the possibility that the true law in its full complexity might include the isolated miracle. Thus, if we consider the right-hand side of the equation $ay = \pm\sqrt{x(x-6)(x-c)}$ we see that it contains the root of $x-c$. That will be imaginary unless x is greater than c: accordingly, y will not have a real value unless x is greater than c. There is, however, one exception to this law, viz. when x is zero. The right-hand side of the equation has the value zero, which is real, and so proves an isolated exception to the general law, which would yet need to be included in a complete statement of the law.[1] Much more important, however, is the definite consideration that many "laws" do not hold beyond a certain range, and in that measure are incomplete statements. To take but one example: In 1662 the Hon. Robert Boyle published the experimental fact now known as Boyle's Law, viz. that the volume of a given mass of gas, kept at a given temperature, is inversely as the pressure, or, in other words, the density of a gas, at constant temperature, is proportional to the

[1] In further partial illustration of the miracle as a regularly unique phenomenon may be cited the peculiar relation of the density of water with varying temperatures. When the temperature is at 212° Fahrenheit—the point at which, under normal pressure, it is transformed into steam—the density is at a minimum. As the temperature falls, the density increases until at 39·2° Fahrenheit (4° Centigrade) it reaches a maximum. From this point down to 32° Fahrenheit water expands, *i.e.* becomes less dense, producing ice, which rises to the top, being lighter than water. Had the condensation continued through these last degrees, following some imaginary law of contraction of volume, ice would have been heavier than water and would have sunk to the bottom, with results that can easily be realised (cf. *Trans. Vict. Institute*, vol. xlii. p. 244).

pressure. As a matter of fact, this law is only approximately true, and while Regnault showed that for low pressures air and nitrogen are more and hydrogen less compressed than if the law were true, Natterer demonstrated that at very high pressures air and nitrogen and hydrogen are all less compressible than the law requires, and deviate the more from it the higher the pressure. The law does not negative these facts: they indicate its incompleteness as a statement, its mere approximation. The true law is more complex than the simple relation that bears the name of Boyle's Law. Indeed, the mere fact that we are dealing with a developing process would seem to imply the emergence of new uniformities or an enlargement in our understanding of the range of operations of the old. Accordingly, it is not surprising that doubts are entertained with regard to the universal validity of such magistral generalisations as the conservation of energy,[1] or that growing expression should be given to the view that the laws of mechanics are not absolute, being, it is stated,[2] mere approximations in many cases, and simply false with regard to velocities comparable to that of light. It is difficult to see how progress could be associated with a closed system. Change under such conditions could only be kaleidoscopic. Yet there *is* progress in the evolutionary process.

It is, however, in face of her tremendous and certainly justifiable belief in the uniformity of Nature that Science has to determine her attitude to miracles. This uniformity the theist explains as the continual manifestation and product of the divine sustaining activity. His belief in a God who is unchangeable, who

[1] Cf. Sir O. Lodge, *Life and Matter*, pp. 21–23.

[2] Cf. *Nature*, vol. lxxxvi. p. 400; *The Evolution of Forces*, by G. Le Bon, pp. 6–8.

is the same yesterday, to-day, and for ever, not merely in His Essence, but in the fundamental method of His working, bears some relation to the scientist's belief in the uniformity of Nature. And whatever the interpretation of miracles may be, certain it is that miracle as a breach of law neither science nor religion knows. We have no experience of anything crashing into the network of law of which we are aware, and breaking it down. If God is *exlex*, as the old schoolmen phrased it,—outside the order of laws under which we are living and with which we are content,—then we have no background for anything except chaos: we not merely have no miracles, but we have no universe, no cosmos. To say that He works according to law is only another way of saying that He is reasonable.

The advance of Science, whatever else it does, certainly increases our sense of wonder in the world. It is not merely the case that many of the commonplaces of modern Science, *e.g.* the activity of the Röntgen ray, would have seemed wonders—miraculous—to past generations; not merely the fact that a great part of the original connotation of a miracle was simply a "wonder" in this very sense; but as the advance of knowledge opens men's minds, they come to realise that the whole is the real miracle, and look for miracle and find it in the whole even more than in the detail. And further, this advance of Science makes many of the recorded miracles more intelligible to us. Every advance, *e.g.* of certain lines of psycho-medical science, all added appreciation of the close relations between the physical and the spiritual,—of the power of mind over matter,—help us to understand better Jesus' miracles of healing. They perhaps represent in a superlative degree the power whereby through

suggestion men and women are even now cured of debasing tendencies and liberated from the prison of their fears. Such powers as He exercised no other one has to-day, or ever had; but the miracles do not violate our sense of reasonableness. Even in the cases which by some are held to show that Jesus was the child of His age (*e.g.* in the ascription of certain forms of disease to demon-possession) we simply have the assurance of His Incarnate Manhood, apart from the impossibility of conceiving how any effect other than bewilderment could have been produced upon those who sought His healing by the adoption of language and conceptions other than those they knew. And while in the case of miracles like the turning of water into wine,[1] or the feeding of the five thousand,[2] what Science hesitates to accept is the apparent break in the continuity of causation, it may be remembered that in many phenomena which are familiar to us—*e.g.* the passage of ice into water, of water into steam, the cinematographic display—there are apparent breaks in the causal series as observed or imagined by us, yet our minds, grasping the whole movement, conceive of the series as continuous.

In fuller illustration of the combined attitude of Science to evidence and interpretation, two miracles may be briefly considered, drawn one each from the Old and New Testaments. In Exodus xvi. 14, 15, 31 and Numbers ii. 7, 8 accounts are given of the miraculous feeding of the Israelites in the wilderness of Sin. In particular, these verses describe the fulfilment of the divine promise, "Behold, I will rain bread from heaven for you . . . in the morning ye shall be filled with bread."[3] In the verses quoted we read, "And when the dew that lay was gone up,

[1] John ii. 1–11. [2] John vi. 5–14. [3] Ex. xvi. 4, 11.

behold, upon the face of the wilderness a small round thing, small as the hoar frost on the ground. . . . And the house of Israel called the name thereof Manna: and it was like coriander seed, white: and the taste of it was like wafers made with honey." Without going into serious critical questions bearing either on the length of the wilderness wanderings or the number of individuals that the nation then comprised—both of which points are of particular importance in connection with this miracle—the first impulse of the scientific mind would be to collect data that are in any sense analogous to the facts recorded in Scripture, and institute a comparison. Thus, to cite two or three data of this character: (*a*) it is known that the tarfa tree (*Tamarix mannifera*, Ehr.) when its twigs are punctured by a scale insect (*Gossyparia mannipara*) exudes a viscous substance which is collected in the desert by the Arabs and sold to pilgrims. Other trees have a similar property, and although the supply of such trees in that particular region is now insufficient for the supposed purpose, it is possible that formerly they may have existed in far greater numbers. (*b*) A lichen (*Lecanora esculenta*) occurs on the desert limestones showing similarity in several respects to the manna of Scripture. It is wind-borne and sometimes swept along in torrential rains, and is used as food in the steppe regions of S.W. Asia in years of famine. (*c*) Preternatural rains of esculent lichen torn away by the winds and borne to a distance have occurred from time to time in Persia, "as at Oroomiah during a famine in 1829, and again at Herat while that place was being besieged."[1] The scientific mind will then weigh the Scriptural statements in the light of facts

[1] *Outlines of Geology*, by James Geikie, p. 10.

such as these. Prof. A. Macalister[1] in considering the first suggestion believes that these exudations are physiologically insufficient as food, and states that they keep indefinitely and cannot be cooked as was the manna, which therefore "was a miraculous substance." But it is conceivable that to others, considerations like those that can be advanced in connection with suggestions (*b*) and (*c*) may appeal, in which case the miracle would lie in the fact that under these particular conditions the Israelites were provided with food in accordance with the divine promise and would be more akin to the old idea of a "special providence."

If in connection with the New Testament we turn to the Resurrection, it is only because than this no miracle is more central, more vital to Christianity. It might have been more fruitful to take a case like the stilling of the lake-storm, and see how far the analogy between the will of man acting upon the energy of Nature and producing results, and Christ's will acting as an extraordinary power upon Nature, would carry us. The electrical discharge of a submarine mine is ultimately the affecting of accumulated energy directly through the will: the material elements are strictly negligible. Once we realise the fact of spiritual agency in the world, it will not be easy to set limitations to it, and in the action of the human will upon energy we have as yet a fact and an unsolved problem. But though in the matter of the Resurrection Science cannot help us with analogy, still, in her critical examination, we believe she can do real service. The scientific study of hallucinations, for example, shows how totally absurd the hallucination theory of the Resurrection is.[2] Hallucinations are

[1] Art. "Manna," Hastings' *Dictionary of the Bible*, vol. iii. p. 236.

[2] W. N. Rice, *Christian Faith in an Age of Science*, p. 369.

usually preceded by conditions of excited expectancy, but the faith of the disciples suffered a total eclipse at the Cross,—they had no expectancy of the Resurrection. Distinctive hallucinations do not usually affect more than a single individual, and they are commonly confined to a single sense: but in the case of the witnesses to the Resurrection it was quite otherwise. Again, in the whole vexed question of the material resurrection of the body as distinct from spiritual immortality, Science will not improbably be heard.[1] But, finally, Science will have to consider in this crucial case not merely the possibility but the probability of such a miracle: here due weight will have to be given to the unique character of Christ and the whole purpose of His life. For as we read again and again the story of His life and the evidence, such as it is, of the New Testament miracles, we realise that it is not because of His miracles that we believe in Him, but that, because of what He was and is, we are compelled to ascribe to Him what, on our plane of humanity, seems to us miraculous. In fact, it is almost impossible to form any satisfactory, *i.e.* any rational conception of His life without the miraculous: there is a certain congruity and intense naturalness in the association of miracle with Jesus Christ. He did not perform miracles so much to prove that He was Christ, as because He was Christ. Could a miracle in itself evoke those qualities—that attitude to Himself—that Christ desires in the believer's heart? And in any case the facts remain that the people of

[1] Sir W. F. Barrett has somewhere hazarded the statement that enough is known mathematically of the conditions of four-dimensional space to enable us to realise that the past resurrection appearances of Jesus Christ, *e.g.* the sudden appearance in the upper room, could quite well be explained on the supposition that during the forty days He moved in space of four dimensions.

His generation were aware of something about Him —that which we express under the term "divine"— which they could only explain by the category of miracle; that His exercise of these powers—His whole use of Himself, so to speak—was contrary to their expectations of what He should do with Himself being what they recognised Him to be, and that, immediately after His public execution, the realisation of His divinity became the central certainty in the lives of numbers of men and women. This realisation received its greatest impetus in the fact of the Resurrection, belief in which, however susceptible to criticism the different accounts may be, must ever be easier than unbelief, for in this world as we know it, it is inconceivable that the greatest instrumentality for morality that history has ever known—the Church of Christ—should have been founded on a lie.

It would seem, then, that the attitude of Science to miracles must be of this nature. In the first place, to deny their possibility is to be untrue to herself. All *a priori* arguments against miracle are purely mental presumptions. Miracles are contradicted by no facts: the facts on which a law is based do not avail beyond these particular facts, nor does the law either, except by an act of faith. In the second place, with regard to recorded miracles, her attitude must be to consider them critically in their setting and general congruity; and thirdly, to admit the possibility of phenomena as due to law that is not yet fully understood. How short is the passage from this position to the theist's conception of miracle as due to the direct action of God supplementary to the course of Nature as known to us may be briefly considered in conclusion. For to one who thinks of Nature as the orderly expression of the working of a divine indwelling Spirit which yet

is not exhausted by the operation of natural forces, and is in that sense transcendent, to one for whom the cosmic order is no rival of God, but rather the continuous manifestation of His sustaining and controlling activity, to whom therefore all events are natural in the mode of their occurrence but supernatural in their causation, it does not seem incredible that God should manifest Himself in ways of which we have no previous or modern experience. Whether the miracle be due to unknown combinations of known natural forces, or to natural forces hitherto undetected, is of no great matter: what is urged is that to maintain that a miracle has not occurred because we do not understand the character of its causation is to make the inadmissible assumption that all that we know is all that is possible—is, in short, to claim omniscience. Nor is it incredible that though God is ordinarily known to us in the order of Nature which He has established as a worthy and permanent expression of His creative and sustaining will, yet should He also manifest Himself for special purposes in some unusual impulse. To deny this is to refuse to God the liberty He has given to man. Particularly is this borne in on us as men come to a clearer understanding of the relations between what have too long been allowed to stand in unreal contrast as the natural and the supernatural. More correctly realised as the physical and spiritual—and to this better understanding nothing has helped so much as evolution—their mutual need and dependence have most impressively been realised. To the earlier mind there was continual conflict between the two: under the conception of spiritual law in the natural world the modern thinker finds no great difficulty in his theistic interpretation of the world-process—God is a Spirit—nor hesitates in his thought of miracle as an

express act of this indwelling yet transcendent Spirit, taking its place in the world order—"an outflash of psychic activity from the realm of eternal Reason not inharmonious with that activity which appears in the regimented phenomena of the world."[1] After all, the characteristic feature of a miracle is not its rarity or uniqueness; it is its clearer indication of the reality of a spiritual world, of the actuality of God's presence in human life. This aspect, while no doubt always with its phenomenal side,[2] will never vindicate itself so much in the character of a natural experience in time and space as in that of an experience of the living God Himself. The only possible explanation of miracle is that in that experience a man becomes directly aware of the actuality and activity of that Energy which ordinarily expresses itself, and is subjectively experienced, in spatial and temporal form. On that transcendental side its value will not lie in the circumstance that it can or cannot be fitted into that "hang" of things which constitutes Science. If the aversion to miracles is simply an expression of belief in a purely mechanical self-contained world, then the human spirit must hail them in defence of its own liberty. For if God be so bound by His laws that initiative is no longer His, much more are we. And if He cannot intervene in the physical realm, still less can He do so in the spiritual, for the two stand in close relationship. The miracle is the sign of the Divine freedom. Yet we may be sure that it is no detached or lawless event: whatever a miracle is, it is not an intrinsically unintelligible thing, a vagary, an ultimatum to Science. With God all rational things are possible, but none is miraculous

[1] C. M. Tyler, *Bases of Religious Belief*, p. 238.

[2] Cf., as illustrating this difference in attitude to phenomena, the incidents in Luke xvii. 11–19, John xii. 28, 29.

to Him. The world must look very differently from God's point of view and from man's, and when ours shall have been changed in greater nearness to His we shall not merely understand the ways of His workings. From what we know of the Divine character we may be sure that we shall realise more fully than we do now not merely that "all's law," but that "all's love."

CHAPTER XVII

EVOLUTION AND IMMORTALITY

THERE is probably a moment in the life of every individual when Job's persistent question in some form demands an answer, If a man die, shall he live again? As one looked on the field of the Khodinka disaster at the time of the Czar's Coronation—"worse than anything I saw at Plevna," as the *Times* correspondent remarked — and saw the old human hulks being jogged off on the top of fire-brigade waggons and other unusual impressed vehicles, the question inevitably rose in one's mind, "Is that the end of the story for them?" Sometimes the individual may feel very certain about the answer; at other times he has greater difficulty, and looks around for every aid in the hours when the immortal hope burns low. Science has helped much in other matters, and some have looked for assistance there, but to the problem she makes no direct contribution; it is difficult to see how she could. At the same time, she throws certain sidelights on the question that do help just a little in its illumination.

She may illuminate the dark sayings of the objector. It is perhaps permissible to maintain that most of the objections to the possibility of immortality have no more profound origin than sheer lack of imagination. To the crude secretion view of Cabanis on the relation

of the brain to thought William James[1] replies in effect, "There are other possible relations than that of production," and then, in particular, starting from the idealistic position that the whole universe of material things is but a surface veil of phenomena, he shows how the facts, so far as they are known, would be equally well, if not better, expressed by the conception of our brains as prisms, through which stream rays of the divine light—rays, however, that are strangely distorted and dimmed by reason of the too constant opaqueness and coarseness of the conducting instruments, our idiosyncratic selves—or as thin and semi-transparent places in the veil through which are diffused into this world suggestions of the true life of souls in all its fullness. Which is particularly interesting when we recollect those cases, by no means confined to sacred records, where, just previous to death, the veil has become preternaturally thin, the prism unwontedly translucent, and the "heavenlies" have broken in on the individual's consciousness ere he has joined himself to them.

Again, the idea of a spiritual body almost seems a contradiction in terms, yet modern conceptions of matter make views of an ethereal body or soul eminently intelligible. "Thou sowest *not* the body that shall be";[2] and the whole conception of a resurrection of the body is but a Pharisaic skin in which the new wine of the revelation of an endless life was first conveyed to men. Physical science can offer to the imagination lines of thought along which the soul or its ethereal counterpart are at least intellectually separable from the grosser material in which it is obliged to accommodate itself here, in order to hold intercourse with other souls and come into relation with the material world. That we have no experi-

[1] *Human Immortality*, p. 30 *et seq.*

[2] 1 Cor. xv. 37.

mental evidence of such an ethereal soul is nothing to the point so far as the suggestion is made to combat the view that the physical dissociation of the elements of the body is the final stage of a human life-history; and on the contrary, there are quite sound reasons why such evidence could not be available.

In short, it is simple dogmatism that would deny immortality: on scientific grounds, at any rate, we have not the knowledge to take up such an attitude. Indeed, when we consider how the potentiality of an adult human organism, brain and all, lies at its primal moment in a speck of matter of microscopic size (0·2 mm.), the difficulty of conceiving some continued relationship between that fully developed consciousness and a minimum of matter, supposing that to be necessary, is not so very great. Across this infinitesimal vital viaduct passes the condensed experience of millions of individuals, showing us that the spirit may safely be given into the keeping of other forms of matter than the brain affords. Hence it is not improbable that matter in certain forms far simpler than the nervous system may bear the germs of high intelligence. What we do know of the slightness of the connection of the personal life with matter at its birth almost justifies us scientifically in affirming that the dissolution of a body is not necessarily the destruction of all relations of the individual to the outward universe. The viaduct for the fair-way of the soul both at birth and at death may be laid from the foundations of the world although it may not in either case be visible to our senses. At any rate, our ignorance of matter and its relation to spiritual activity is so profound that the fact of a capacity for death cannot be made the basis for an induction as to the non-survival of intelligence.

On the positive side we are unaided by science towards an absolute demonstration. At the same time, there are many suggestive things—"Intimations" Wordsworth was bold enough to call them—that help us in our trust. They are of very different value, but their cumulative effect is not inconsiderable. One of these is the existence of what have been called critical points or crises in the economy of Nature.[1] A not unnatural deduction from the doctrine of the conservation of energy, due to preoccupation with its modes of transformation and the routine of antecedent and consequent, leads men to imagine that there is a definite uniformity of quality of action in Nature. But is it so? Consider the story of a crystal of ice. It is definitely recognisable as such with its characteristic qualities, and these it would retain under certain conditions indefinitely. But subject it to heat, make some slight change in its environment, and at a certain point it no longer conforms to the old environment but has been transformed into something else—water. With regard to this transformation two things in particular are noticeable. In the first place, the change with its results and the vastly different qualities of the new substance could not have been predicted from any study of the ice crystal as such; in the second place, the difference in the environment, the change in the temperature required to bring about this transformation, is immeasurably small. We say 32° Fahr. is the point, but it is, so to speak, something much smaller, done in something less than the span of a degree of temperature. Follow the process further. Increase the heat, and again at a certain point a wonderful transformation takes place. The drop of water is no longer there; it has disappeared, but it is

[1] N. S. Shaler, *The Individual*, p. 292.

not lost. And all our study of the water-drop as such would never have led us to imagine that with this immeasurably small change of temperature it would have been so transformed. Such transformations in Nature are by no means the exception. The suggestion is, that death, perhaps, is just such a critical point, when there is a change to something in an entirely new realm, of which we can form no conception from our study of the living body. The difference in temperature of water as ice or fluid and as fluid or vapour is extremely small, and yet how great is the effect of this difference! Each is a point at which origination of quality is in some way introduced.

A further consideration springing out of the relationship of man to his environment has been urged with great force by Fiske.[1] If man is indeed but a physical being, why is he, unlike all other creatures, not satisfied with proper physical conditions? What has he to do with a spiritual environment at all? If all values to him perish with the body, what is the meaning of his instincts and affinities for the spiritual, the infinite, the perfect, the permanent? He does not find his satisfaction, his true life, in ends that centre in his body as a rule—there are exceptions, but we do not call them men. Is not history replete with tales of those who, for the sake of realising their nobler life, have sacrificed their bodies in devotion to truth and justice? Perhaps, it is objected, the instinct was misguided and corresponds to fancy only—to nothing, *i.e.*, external to him. But is it not strange that God should have so constituted man that he feels himself to be truly living only so far as he seeks the spiritual, the perfect, the permanent, if there is naught in his environment and destiny corresponding to such a nature? It is not

[1] John Fiske, *Through Nature to God*, chap. x.

merely strange but anomalous in the world as we know it. For every advance and every feature of man's life has been evolved in response to something external to him. The eye has been developed in response to ethereal undulations, the ear in reply to the impact of the waves of sound; maternal love has been elicited by a little child, and every virtue we possess has been developed under the stimulus of something noble but originally external to us. And does this spiritual sense —this within us that is felt to be greater than all that is around us—alone correspond to nothing real and external to us? That the human spirit should be united with a physical body for a time for character formation and all higher education—even for mere purposes of communication in a physical sphere—is not perhaps unintelligible. But that this spiritual nature, whose scope and outlook is the Infinite, should vanish with the body is contrary to the whole cosmic economy, which uniformly subordinates the lower to the higher; that it, the subjective and the temporary, should alone be the real and correspond to nothing externally, would be the sole irrationality in the universe as we know it. Rather are we compelled to think of ourselves as finely minted coin; and to every characteristic mark and feature do we feel certain that something corresponds in the die in whose image we are created. In many the image is defaced somewhat in the hard usage of life, but we can well imagine the divine Artificer making the sole test depend on whether in the end the individual coin rings true, in which case it is gold and will not perish, standing the fire.

Possibly the most effective considerations are those derived from the rationality of the universe taken in conjunction with the teachings of evolution. Evolution

has entirely changed our conception of man. Time was when he was considered as absolutely distinct from, and having no relation in origin with, the brute creation around him. He was placed on a pinnacle by himself, and all accounts of the universe began with him, and explained everything from him; they were worked out from above downwards. The modern story leads up to man through the rest of the creation: it displays his kinship with the lower creatures, but also emphasises that wherein he is alien to them. It shows that not 6000 years but mayhap 600,000 years ago man arrived, and tells of ages of previous life that were not altogether unconnected with him. In man Science sees the goal of creation: she assures us that there will never be a creature higher than man; she recognises in him the consummation of the whole. And these two views differ in dignity, truth, and service as do the Ptolemaic and Copernican theories of the motions of the heavenly bodies. But from the side of pure materialism we are invited to believe that this age-long process has been set in motion to produce man, and that at death its fairest blossom is merely thrown out into the night. We are shown a long line of ancestry whose beginning is lost in the seemingly interminable past—groups of creatures crossing the stage of existence, playing their little rôle, and for the most part disappearing or giving rise to other forms. We are shown a series unbroken yet sharply marked by values of increasing worth, till at the end comes man—most truly man when dominated by love and conscience. He has closed the series because he has revealed its final cause in himself, so that we are fain to say that in order to produce man it was necessary to evolve the tenuous but persistent line of life from Cambrian days until this present. In face of the thousands of pro-

gressive distinct modifications that led up to the estate of man, what were the chances of such a process working out correctly if it were not guided, if there had not been this end in view? They are infinity to one. So that, as we look down the long vista, we refuse to believe that in man's case death ends all. To do so is to rob not only existence but the process of its meaning. Man is the outcome of the travail of a universe, and it were strange if there is no value associated with him exceeding the cost of his extraction. Is it conceivable, then, that this age-long process is to break down at the last stage? Unless life is some gigantic anticlimax, it cannot well be so. What is unreasonable in supposing that just as man's body has nearly reached the goal of terrestrial development, so his soul, his spirit, may just be commencing a corresponding career that shall be continued hereafter? Rather, therefore, do we hold that the final goal, the only reasonable conclusion of that world process whose aim is the continued perfection of adaptation to environment, is the begetting of souls faultlessly adapted to the spiritual world, the moulding of beings whose life has acquired that selective value upon which the forces of the world to come can fasten, and will therefore possess survival value beyond the environmental change of death. That is to say, there may well be human discontinuous variations in the direction of "an endless life," and death be for them no more than a "break."

Further, with the possibility, nay the probability of continuity admitted, speculation has sometimes busied itself with philosophical inquiry into the nature of the change, with the question whether it is undergone by all men, whether there may not be some winnowing process going on even now, whereby, although in every man there is the possibility of survival, yet

may it not become a reality. Again the question rises, what is it that persists? In an evolutionary process that has tended towards higher and higher individuation we have to try and find out wherein this individuality consists. We have realised the dividuality of humbler forms [1] and are aware of a certain permanence beneath the outward changes that constitute the life-history of higher forms, until in the case of man the significance of individuality becomes so great, and its effects so strangely persistent, that it looks as if we had not yet learned to appreciate it in its fulness, and perhaps have not all of us attained it in its supreme form. This failure to appreciate individuality is illustrated by Professor Royce in a passage of singular beauty,[2] in which he takes as example that individuality which every man is perfectly certain he can describe—namely, that of the woman whom he loves. And yet, he maintains, when you examine and analyse the descriptions of a dozen lovers, you find that they are all saying pretty much the same thing, although necessarily and fortunately about different individuals; are in fact, each of them with the beatific vision before his eyes, yet only describing a type—the perfect woman—and utterly failing to convey anything to you by which you can lay hold of the individuality of that particular one whom he loves. "So careful of the type he seems—so careless of the single life," which is "an insult to loyal love," but at the same time an expression of a lack of achievement, so suggesting that perhaps we attain to immortality what time this human bundle of sensations, feelings, and aspirations shall have put on Individuality, what time it shall have attained to that degree of self-conscious moral personality which has come into new and eternal

[1] P. 95. [2] *The Conception of Immortality*, p. 64.

relationships both with the universe it inhabits and with the Supreme Personality in that universe, and as a consequence cannot possibly be holden of death.

Considerations of this nature, together with the whole method of Evolution, seem to point in the direction of the theological doctrine of Conditional Immortality. Now it was Plato, not Jesus Christ, who taught that the soul is inherently immortal; and the further fact remains that if we exclude the Platonic myth there is no conception of immortality in or out of Scripture that is not in some vital sense conditional. Accordingly, if it appear that immortality is a moral achievement, conditioned in part by our own efforts, in part by our alliance with God, there is nothing in Scripture to challenge the contention. "Good Teacher, what shall I do that I may inherit eternal life?" asked one of Jesus,[1] and the Teacher did not at any rate correct his view of immortality as an attainment. On the contrary, His teaching on this hope is comprehended in the categories of life and death.[2] "The Gospels are biological altogether."[3] Jesus Christ placed before men the conditions of "immortability": He showed the way of eternal life, with its adaptation to its particular environment, which is God. Nor did the earliest Christian writers understand His teaching on this matter in any other sense. Nowhere in their writings is a hint to be found of a belief in the natural immortality of the soul; their declarations follow the typical conception of their Teacher. They speak of the attainment of the conditions as something to be "striven" after.[4]

[1] Mark x. 17.

[2] John iii. 16, v. 24; Matt. vii. 13, 14, etc.

[3] S. D. McConnell, *The Evolution of Immortality*, p. 110.

[4] Col. i. 29.

"Blessed," says James, "is the man who survives the moral test, for the issue is life."[1]

What, then, is the nature of this achievement of immortality? Essentially the condition is moral. The precise moment is often not easier to indicate in the individual life than that at which self-consciousness has dawned. We have seen the tremendous range of mental achievement within the human race, and the range of moral achievement is not less. In self-consciousness is revealed the ordinary climax of the individualising process; the individual becomes aware of the possibility of its individuality. Even on the purely physical side the fact that the prodigality of life is increasingly checked as it progresses, until in man it affects both the period of reproductive power and the number of offspring suggests an increasing value. But humanity includes many units that are not men, in the highest connotation of the term. Until a man appreciates not merely the abstract distinctions between good and evil, but also the practical personal responsibility in right and wrong doing,—its present determining influence,—he cannot understand the implications of this present life, the possibilities of a higher life, the conditions of the attainment of immortality. To the man who has never known or experienced anything in his life for which he is willing to die, Immortality must ever be a chimera. On the other hand, the more intense and rich the life of the spirit—the more adapted it is in any specific case to the true environment of souls—the more does the thought of extinction become impossible, the more certain is the conviction, nay the present awareness, of immortality. To be "united

[1] Jas. i. 12, as rendered in McConnell, *op. cit.* p. 119, to which reference should be made for a detailed treatment of this point.

with Christ" represents a spiritually and morally tempered condition of prepotency whose survival of death is natural. It represents a moral achievement that was likewise open to those who in spirit saw His day afar off and were glad, if there is any truth in the doctrine of the pre-existence of Christ.

The older Scripture writers reached their belief in immortality as the result of experiences that we can share with them. Communion with God was to them something so real, so great, so necessary, so satisfying —a man's moral relation to God so absolutely constituted the bond of the diverse elements in his nature, *i.e.* his individuality—that the mere thought of the interruption of this fellowship by death elicited a protest, "Thou wilt not leave my soul to Sheol; neither wilt Thou suffer Thine Holy One to see corruption."[1] Fellowship with God would last through death: the believer demanded that he should overleap Sheol and pass to God—"But God will redeem my soul from the power of Sheol, for He shall receive me."[2] And Christ had the same intense conviction: "My Father, which hath given them unto Me, is greater than all; and no one is able to snatch them out of the Father's hand."[3] Christ was inexpressibly certain of Immortality just because His earthly life was inexpressibly perfect and beautiful, and in complete harmony with God. Therefore it is that we can understand that it was not possible that He should be holden of death—that it was, in short, natural that He should live. Therefore it is that we believe Him as we hear Him say majestically, "I am the Resurrection and the Life: he that believeth on Me, though he die, yet shall he live: and whosoever liveth and believeth on Me shall never die."[4]

[1] Ps. xvi. 10. [2] Ps. xlix. 15. [3] John x. 29. [4] John xi. 25, 26.

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